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SAFER SIGN AND LUMINAIRE SUPPORTS

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Task G. Laboratory Testing of Supports

February 1976
Final Report

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FEDERAL HIGHWAY ADMINISTRATION
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Washington, D.C. 20590

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16. Abstract

Results of laboratory tests conducted at the Federal Highway Administration's Impact Test Facility are reported in this task report. A description of the impact test facility is given, along with testing procedures followed at the facility. The tests performed are described and results are summarized in tabular form. Support specimens tested include slip-base steel luminaires, aluminum shoe-base luminaires, and dual-legged sign supports.

This task report is part of a study in which a full investigation into impact phenomenum of vehicles with breakaway supports was made and acceptance testing procedures for sign and luminaire supports were developed.

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ABSTRACT

Results of tests conducted at the Federal Highway Administration's Impact Test Facility are reported in this task report. A description of the facility is given, along with testing procedures followed at the facility. The tests performed are described and results are summarized in tabular form. Support specimens tested included slip-base steel luminaires, aluminum shoe-base luminaires, and 8WF20 sign supports.

TABLE OF CONTENTS

		Page
1.	INTRODUCTION & SUMMARY	1
2.	TEST FACILITY DESCRIPTION	4
3.	TESTING METHODOLOGY	6
	3.1 Pre-test Set-up	6
	3.2 Test Procedure	14
	3.3 Data Reduction and Analysis	17
4.	DESCRIPTION OF TESTS	25
	4.1 Slip Base Steel Luminaire Tests	25
	4.2 Aluminum Shoe Base Luminaire Tests	33
	4.3 Dual-Legged Sign Support (8WF20) Tests	33
	4.4 Dual-Legged Sign Supports (with Rigid Face Pendulum) Tests	37
5.	SYNOPSIS OF LABORATORY TEST RESULTS	40
APPENDICES - TEST DATA		
	A. Steel Luminaires with Slip Bases	43 - 145
	B. Aluminum Luminaires with Shoe Bases	146 - 188
	C. Dual-Legged Sign Supports (8WF20) with Slip Bases	189 - 228
	D. Dual-Legged Sign Supports (8WF20) with Slip Bases Struck by Rigid Pendulum	229 - 319

1.0 INTRODUCTION AND SUMMARY

An important aspect of the present contract was the laboratory testing of selected sign and luminaire supports using a pendulum impact device. The purpose of this Task G was to utilize the pendulum for gaining more understanding of the impact phenomenum of a vehicle with a breakaway support, and secondly to develop a procedure whereby a pendulum impact test could be used for acceptance testing of sign and luminaire supports.

The pendulum represents an easily controlled, fairly repeatable impact device which is very effective for understanding the performance of breakaway supports. It enables one to investigate such questions as effect of vehicle crush rate on momentum change, effect on inertial properties on momentum change, effect of pre-load in slip base bolts on momentum change, etc. Use of the pendulum impact device in conjunction with detailed mathematical models of the vehicle/support impact phenomenum represents a very powerful tool for gaining a complete understanding of the performance of a breakaway support and, at the same time, methods for improving it.

Use of the pendulum as an acceptance test device for breakaway supports is very attractive since it represents a much more cost-effective approach than use of full-scale impacts. The major thrust of the present contract was to demonstrate that a pendulum device fitted with an appropriate crushable nose module can be used to reliably predict the momentum change experienced by a typical full-scale vehicle and consequently be used to test the acceptability of sign and luminaire supports.

In this task report a brief description of the impact test facility, which was developed in this contract, is given, followed by a description of the procedure required to conduct

meaningful repeatable tests and the methods required to reduce the data to find the induced momentum change.

Descriptions of the tests carried out during this contract at the facility are given. Initially dual-legged sign supports (8WF20) were tested (test series 200). During this phase the honeycomb crush module attachment was developed. A series of steel luminaires (test series 000) with slip bases were then tested and the momentum change associated with the impacts computed. Parallel full-scale impact tests were done on these luminaires at TTI and the momentum values experienced in the full scale and pendulum impacts were compared. At the same time a parametric study concerning the pre-load on bolts of the slip base versus momentum change was carried out. As expected it was found that as bolt pre-load increases the momentum change associated with the impact increases also.

Pendulum impact tests (test series 100) were carried out on aluminum luminaires with shoe bases. These bases were found to be quite unrepeatable in their performance and often induced momentum changes beyond the acceptable limit of 1150 lb_fsec. Again parallel full-scale tests at TTI were carried out on these supports to see how well the pendulum momentum changes match the full-scale values. The final series of tests (series 300) utilized dual-legged sign supports and was concerned with estimating the portion of the momentum change which is associated with the inertial properties of the support. It is important to understand this since the performance of the support at higher impact speed (40 mile/h and above) can be dominated by this factor. By using a rigid face pendulum (which effectively eliminates any momentum change going into crush deformation) and striking a loosely held support (which eliminates any momentum going into base fracture) the momentum change due

to accelerating the support can be effectively measured. It was shown that an analytical results (see Task F also) can be reliably used to estimate this value.

The actual test data taken at the facility during this contract is given in Appendices A through D. A synopsis of the test results is given in Section 5.

2.0 TEST FACILITY DESCRIPTION

The FHWA Pendulum Impact Facility in Riverdale, Maryland was developed by ENSCO, Inc. as part of contract DOT-FH-11-8118, "Safer Sign and Luminaire Supports." It was developed primarily as a repeatable full-scale vehicle simulator for the acceptance testing of sign and luminaire supports. It is, however, adaptable to a variety of other ballistic pendulum uses.

A photograph of the facility is shown in Figure 1. The pendulum mass, which can be varied between 2,000 and 4,500 lbs., swings by four wire ropes suspended from the 38-foot high pendulum tower. The wire ropes are arranged in a parallelogram configuration in order to keep the mass parallel to the ground at all times. The mass is raised to its maximum height of 21 feet by an electric winch. When released from this height, the mass reaches a speed of 25 mph at impact. Slower impact speeds can be achieved by releasing the pendulum mass from lower heights.

The pendulum facility has a soil pit in which the foundation of the sign or luminaire support is placed. Various soils can be placed in the pit, allowing different types of foundation soils to be analyzed. Dry sand was used as a foundation soil for the tests carried out in this series.

A crushable aluminum honeycomb nose module is attached to the impacting face of the pendulum mass for imparting a controllable force build-up on the test specimen. The force-deflection characteristic used in the present tests was designed to simulate the crushing forces of a typical automobile front end.

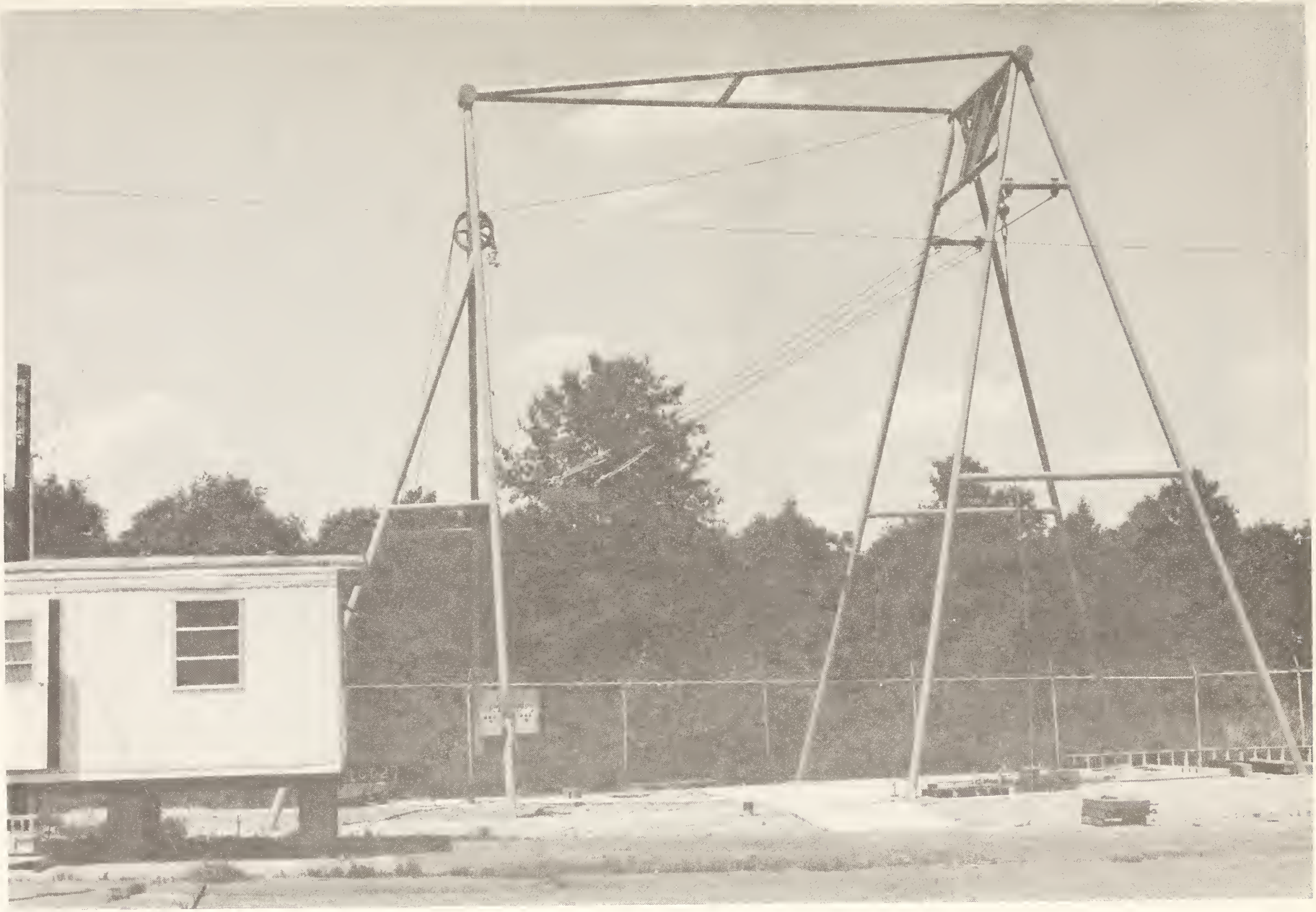


Figure 1. FHWA Impact Test Facility

3.0 TESTING METHODOLOGY

In order to ensure valid repeatable tests, a standard test practice was followed. Adhering to this practice was found to be effective in eliminating human error and operator bias.

3.1 PRETEST SETUP

Prior to any test at the impact facility, a Test Request Form is completed. A sample form is shown in Figure 2. This form, when completed, establishes the test setup and forces the engineer to analyze the various test options available to him prior to the start of the test. Using this completed form, support personnel can prepare the facility for the test.

Preparation of the facility for the test begins in the laboratory. Honeycomb material must be cut to size for use in the crushable nose module. Accelerometers and speed transducers must be checked out to ensure proper operation. In addition, any special attachments for supports and/or bases being tested must be fabricated.

At the test site, the procedure shown on the test checklist, Figure 3, is followed. First, power is turned on at the circuit breaker box located in the facility trailer. The release hook is attached to the pendulum mass and power connected to the winch. (It is assumed that the correct pendulum mass has previously been attached.) The accelerometers are now installed on the mass and calibrated. The speed transducers are set in place and checked out. The high-speed camera is loaded and all dials properly set. At this time, the honeycomb is installed

FHWA IMPACT TEST FACILITY

TEST REQUEST

Test No. _____

Pole/Support _____

Description of Setup: _____

_____

_____

_____

Camera: Required yes ☐ no ☐

Film Color ☐ B&W ☐

Min. Speed _____

Max. Speed _____

Signals to be Recorded:

a. Accelerometers yes ☐ no ☐

b. Strain gauges yes ☐ no ☐

c. Speed transducers yes ☐ no ☐

d. Other _____

Figure 2. Test Request Form

Crushable Nose Characteristics:

Honeycomb #1 _____

#2 _____

#3 _____

Initial Speed: _____

Weight of Pendulum Mass: _____ lbs.

Comments: _____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Figure 2. Test Request Form (continued)

FHWA IMPACT TEST FACILITY

TEST CHECKLIST

Test No._____ Date:_____ Weather:_____

Personnel Present:_____

1. POWER

Circuit breakers on

1 ☐ 2 ☐ 3 ☐

4 ☐ 8 ☐ 10 ☐

11 ☐ 13 ☐ 14 ☐

2. RELEASE HOOK

Attached ☐ Plugged In ☐ Switch On ☐

3. ACCELEROMETERS

Mounted Correctly ☐

#1 Connected ☐ _____ g's

#2 Connected ☐ _____ g's

#3 Connected ☐ _____ g's

Mounting Pattern of Pendulum Mass (Viewed from Rear) ☐ ☐ ☐ ☐

J-Box Connectors tightened ☐

J-Box Cable connected to Control Box ☐

Figure 3. Test Checklist

#1 _____ volts Balanced ☐ Excitation ☐ Amp. Bal. ☐

_____ gain #_____ channel into Tape Recorder

#2 _____ volts Balanced ☐ Excitation ☐ Amp. Bal. ☐

_____ gain #_____ channel into Tape Recorder

#3 _____ volts Balanced ☐ Excitation ☐ Amp. Bal. ☐

_____ gain #_____ channel into Tape Recorder

4. SPEED TRANSDUCERS

Slots lined up ☐

Distance between first two _____ ft.

Distance between second two _____ ft.

Distance between sets _____ ft.

Connected correctly to control box ☐

Control box on ☐ Reset ☐

Voltage Setting on Control Box:

1 _____

2 _____

3 _____

4 _____

R _____

Figure 3. Test Checklist (continued)

5. CAMERA

PPS Dial _____ Mult Switch _____

Speed Reducer _____ Servo Brake _____

Drag Brake _____ F Setting _____ Film ASA _____

Light meter reading _____ Film _____

Film correct ☐ Prism correct ☐ Trip switch ☐

Camera on stop ☐ Timing light on ☐ _____pulses/sec

Balanced ☐ Remote cable on ☐ Power cable on ☐

Focus setting _____ Lens Cap off ☐

View portal correct ☐

6. CRUSH CHARACTERISTICS

Honeycomb: #1 _____

#2 _____

#3 _____

7. POLE Type: _____

Set up ☐ Torqued exactly ☐ Torque _____ ft-lbs.

Figure 3. Test Checklist (continued)

8. TIMING LINES

Frequency _____ hz Voltage (peak to peak) _____ volts

Recorded on channel _____ input to tape recorder

9. TAPE RECORDER Tape # _____

Speed _____ips

Start of calibration _____

End of calibration _____ Meter Setting

Start of Test _____

Calibration signals recorded ☐

10. MASS

Weight _____lbs.

Correct height ☐ Est. initial velocity _____mph

Accelerometer cables out of danger ☐

Figure 3. Test Checklist (continued)

11. LAST SECOND ITEMS

Arm control box ☐

Initial # of Pulses (rec) _____

Final # of Pulses (rec) _____

Impact meter reading _____

Final meter reading _____

Amount of crush _____

Remarks:

Figure 3. Test Checklist (continued)

in the special honeycomb holder on the front of the pendulum mass. Finally, after all other work outside the trailer has been performed, the specimen support itself is erected. Inside the trailer, the tape recorder is turned on and initialized.

During this pretest phase, all data and comments are recorded on the test checklist as they are performed.

3.2 TEST PROCEDURE

Before the test sequence is begun, the area near the pendulum is cleared of personnel and equipment. This is because impact of the pendulum mass with the support can cause the support and associated debris to be carried down-range as far as 50 feet; on some tests, the base or coupling will be shattered and pieces will fly in all directions. Consequently, care must be taken to protect all people and equipment in the nearby environment.

The pendulum mass is raised to the desired height just before the test is to begin. The speed transducers are now armed. Once the start button is pushed, the countdown sequence begins automatically. Twenty seconds later, the camera starts and two seconds after that the pendulum mass is released. The tape recorder is started just prior to pendulum release and turned off, along with the start switch, after completion of impact. (If an emergency arises after the start button has been pushed, pushing it again, before pendulum release, aborts the test.)

In testing programs utilizing this facility, it is intended that data should be reported on the standardized Test Result Data Sheet (Figure 4).* Figure 5 explains how this sheet should be completed. Use of this data sheet will result in better control and cataloging of the test data associated with given sign or luminaire supports.

---

* This data sheet is also intended for full-scale vehicle impact tests as well.

TEST RESULT DATA SHEET

SUMMARY

IMPACTING MASS _____ IMPACT SPEED _____
STRUCTURE _____
PEAK DECELERATION _____ ΔMV _____
COMMENT _____

TYPE OF TEST

_____
_____

TYPE OF STRUCTURE (ATTACH DRAWING)

_____
MATERIAL _____ GAUGE _____ ALLOY _____ HEAT TREATMENT _____
DESCRIPTION OF (ATTACH DRAWING) _____
IMPACT GEOMETRY _____
PHYSICAL CHARACTERISTICS: WEIGHT _____ RADIUS OF GYRATION _____
DIAM (TOP) _____ DIAM(BOTTOM) _____ LENGTH _____
C.G.(FROM BASE) _____ HT OF IMPACT PT _____
BREAKAWAY FORCE _____ COMMENT _____
_____

FOUNDATION

LENGTH _____ DIAMETER _____ MATERIAL _____
SOIL DESCRIPTION _____

PENDULUM OR VEHICLE

DESCRIPTION _____

DATA ACQUISITION SYSTEMS

ACCELEROMETERS

IMPACT DURATION _____ AVERAGE G-LEVEL _____
PEAK DECELERATION _____ ΔV _____ MΔV _____

PHOTOGRAPHIC

IMPACT DURATION _____ MAXIMUM DEFORMATION _____
V(FINAL) _____ V (INITIAL) _____ ΔV _____
MΔV _____ TIME OF BREAKAWAY _____

SPEED TRANSDUCER

V(INITIAL) _____ V(FINAL) _____
ΔV _____ ΔMV _____

RESULTS

FOUNDATION _____
MOVEMENT _____
DESCRIBE DAMAGE (PRIMARY & SECONDARY IMPACT) _____
_____
COMMENT _____
_____

TEST LOCATION _____ TEST DATE _____
PERFORMED BY _____

Figure 4

NOTES FOR PREPARING TEST RESULT SHEET

This data sheet should be used to record the results of all pendulum impact tests. It may also be used for reporting full-scale tests.

SUMMARY

Impacting mass (pendulum or vehicle) in lbs., initial speed in mph
Type of structure - pole, sign support, etc.
Deceleration in g's, momentum change in lb_f-sec.

TYPE OF TEST

Full scale, pendulum, etc.
Frontal or side impact

TYPE OF STRUCTURE

Attach drawing of structure, base, etc.
Type - luminaire, sign support, etc.; manufacturer, mounting height, mast arm, etc.
Material - steel, aluminum, wood, etc.
Describe type of base and estimate force needed to activate breakaway mechanism.

FOUNDATION

Describe physical dimensions.
Soil.- clay or sand, hard or soft, wet or dry.

VEHICLE

Pendulum - rigid face or crushable nose
Vehicle - model, year, type

DATA ACQUISITION SYSTEMS

Record times in milliseconds, decelerations in g's

RESULTS

Record any movement of foundation and describe damage due to impact.

Figure 5

3.3 DATA REDUCTION AND ANALYSIS

During the test, acceleration data is collected from the matrix of accelerometers attached to the pendulum mass. Usually three are used, the two primary ones, having a 15 g range, are located 2" either side of the centerline of the pendulum mass; a third accelerometer having higher range, say 50 g, is also installed so that in the unlikely event of saturation of the two primary accelerometers, data can still be collected. Speed transducers are used as a direct method of determining the velocity of the pendulum before and after impact. High-speed film is used to record events during the impact and allow detailed investigation of the actual impact phenomenon. The honeycomb deformation is measured at the end of the test to give a value of the peak impact force.

Details of how the accelerometer and speed transducer data is used to given momentum change are given in the following sections together with further discussion of the high-speed film and honeycomb crush data.

3.3.1 ACCELEROMETER DATA

The data from the accelerometers is recorded on the tape recorder at high speed and is then played back at the slower speed of 1-7/8 ips for transfer to an analog strip chart or oscillograph. The calibration signals are first displayed on the strip chart followed by the accelerometer traces. The gain of the strip chart must be set to insure that the tape peak output voltage is below the peak display voltage. A typical accelerometer trace is shown in Figure 6 with corresponding calibration and timing signals, Figure 7.

Using the accelerometer traces, the change in linear momentum is determined by measuring the area beneath the acceleration-time curve. This is done manually with a planimeter. The steps followed for a typical deceleration curve are:

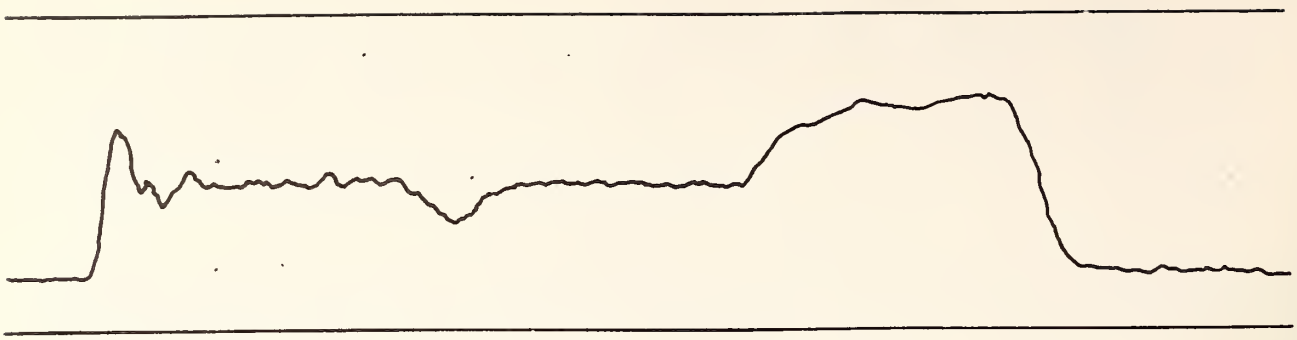
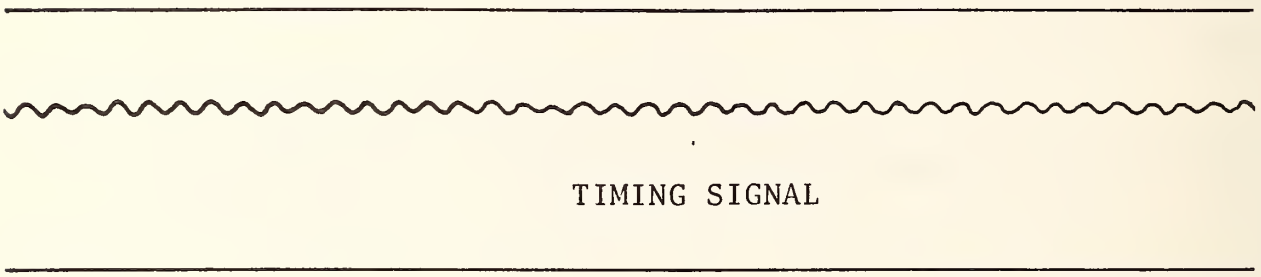


Figure 6. Accelerometer Signal



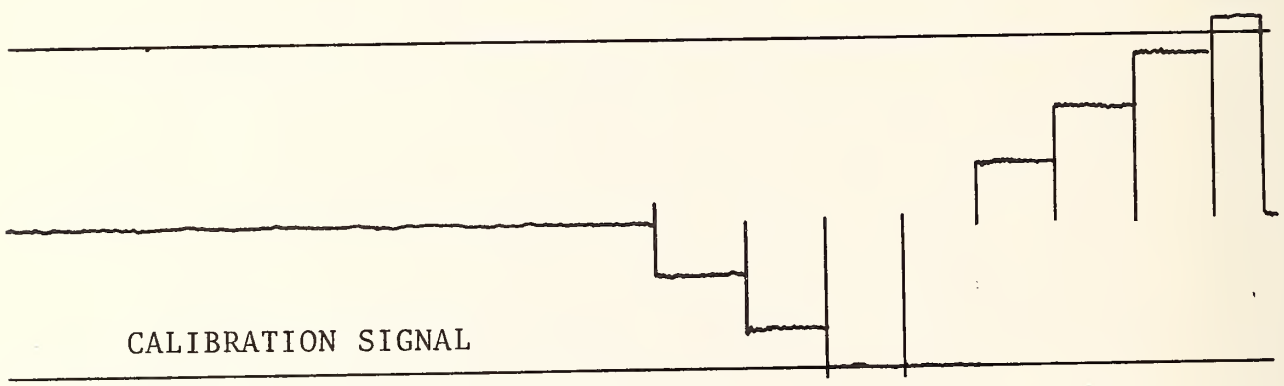
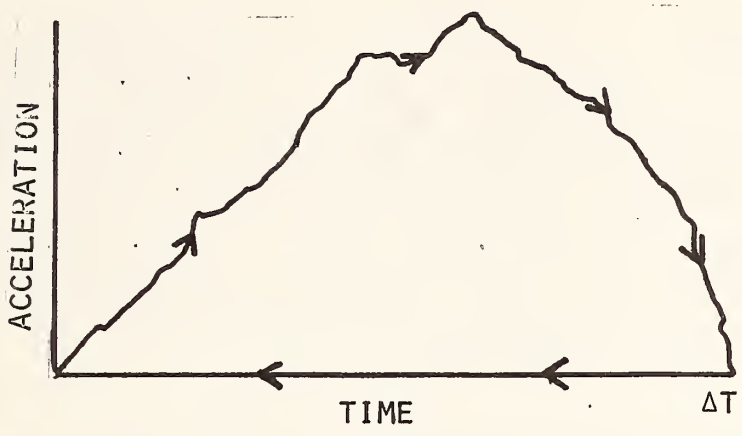


Figure 7. Timing and Calibration Signal

1. Using the planimeter, the area under the curve is determined in the direction indicated. This measurement is repeated several times until a good average value is determined.



Acceleration-Time Trace from Strip Chart

2. A rectangle is fitted around the acceleration-time curve whose height is equal to the peak acceleration and length is equal to the impact duration. The area and height of this rectangle are measured and recorded.

3. Using the accelerometer calibration curve, the acceleration per unit height is determined. This number α gives the number of g's per division.

4. The average acceleration experienced by the mass is determined as follows:

$$\text{Avg. acceleration} = \alpha \left\{ \frac{\text{area under accel. curve}}{\text{area under rectangle}} \right\} \quad \left(\text{height of rectangle} \right)$$

5. The change of momentum is computed as follows:

ΔMV = weight of pendulum mass (lb_f) · ΔT(sec) · Avg Acceleration (g's)

6. This change of momentum value is computed for each of the primary accelerometers (left and right) and the results averaged. (All the information should be entered on the data reduction sheet, Figure 8.

3.3.2 SPEED TRANSDUCERS

During the impact test, two sequences of pulses from the speed transducers are recorded, one for the initial speed and one for the final speed. The number of pulses in the first sequence corresponds to the time required for the mass to pass over the first set of photo cell transducers. Using this number, the initial speed is calculated as follows:

$$\text{Initial speed} = \frac{(50{,}000 \text{ pulses/sec}) \cdot (X(\text{ft}))}{\text{No. of pulses}} \text{ ft/sec}$$

where X is the distance between the two photo cells.

Similarly, the number of pulses in the second sequence corresponds to the time required for the mass to pass over the second set of photo cells. Since the pendulum mass tends to climb upwards after passing over the first set of transducers, we must compensate by using a correction factor for height. The final speed is computed as follows:

$$\text{Final speed} = \frac{(50{,}000 \text{ pulses/sec}) \cdot (X(\text{ft}))}{(\text{No. of pulses}) \cdot (\text{Hc})} \text{ ft/sec}$$

where X is the distance between the second two photo cells and Hc is a correction factor for height.

To determine the correction factor, the distance between the photo cell trip arm extending from the side of the pendulum, when it is in the neutral position, and the first photo cell

TEST # _____

DATA REDUCTION
FHWA/ENSCO IMPACT TEST FACILITY

1. Speed Transducers

A) Initial pulses _____:Cor. Factor _____ → _____fps = _____ mph

B) Final pulses _____:Cor. Factor _____ → _____fps = _____ mph

Weight of mass = _____ lbs.

ΔMV = (weight /32.2) x (final-initial speed) $lb_f sec$

= _____ $lb_f sec$

2. Accelerometers

	Accel. Trace Area	Rectangle Area	Height of Rectangle	Height of Cal.Curve	Cal.g's	$\bar{g}$	Δt (ms)	Peak g's	$\Delta(MV)$
	_____	_____							
#1	_____	_____	_____	_____	_____	___	___	_____	_____
	_____	_____							
	_____	_____							
#2	_____	_____	_____	_____	_____	___	___	_____	_____
	_____	_____							
	_____	_____							
#3	_____	_____	_____	_____	_____	___	___	_____	_____
	_____	_____							
	$\bar{g}$								

Average momentum change $\overline{\Delta(MV)}$ = _____ $lb_f sec$

DATE _____ _____

Figure 8

of the second set is determined. A similar measurement is also made for the second photo cell of the second set. The average of these values is used to find the corresponding correction factor using the graph in Figure 9 and 10 (depending on initial speed). A value of Hc will normally be between 0.9 and 1.00.

The change of momentum (ΔMV) for the impact can then be computed as follows:

$$\Delta MV = \frac{\text{weight of mass } (lb_f)}{32.175\ (ft/sec^2)} \text{ (initial speed-final speed)(ft/sec)}$$

3.3.3 HIGH-SPEED FILM

The high-speed camera is able to record many events of the impact that cannot be recorded with instruments or seen with the naked eye.

From studying the film, the length of time that the pole was in contact with the mass, the length of time the honeycomb took to crush, and the time interval during which the pole began to slip can all be determined. By looking at the films, important aspects of movement (such as base movement, foundation movement, pole rotation, etc.) are also pinpointed.

3.3.4 HONEYCOMB CRUSH

The honeycomb is a permanent record of the amount of crush produced by the impact of the mass with the pole. This crush can be measured accurately and since its force deflection characteristics are known it can be used to determine the peak force level reached.

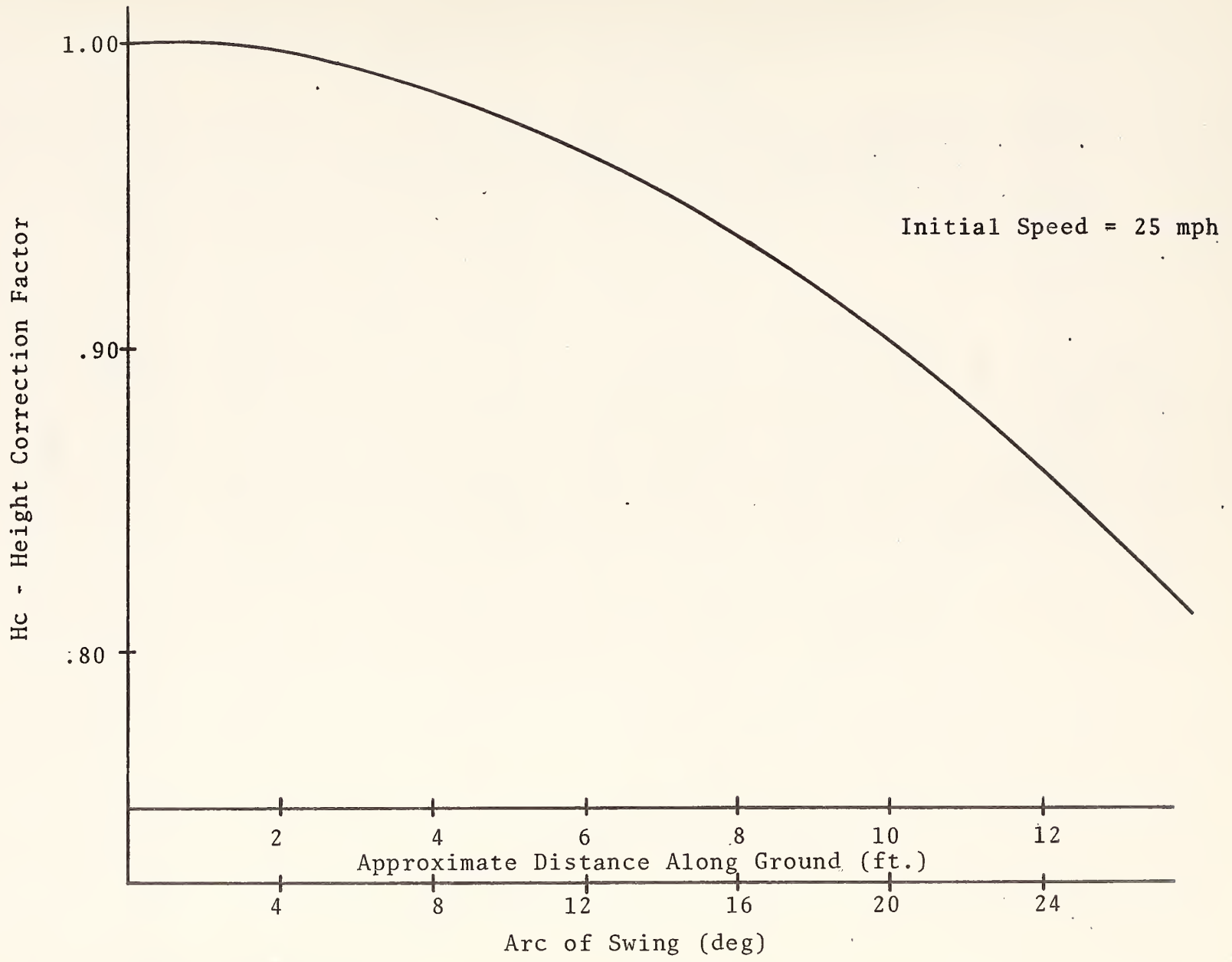


Figure 9. Correction Factor for Speed Transducer

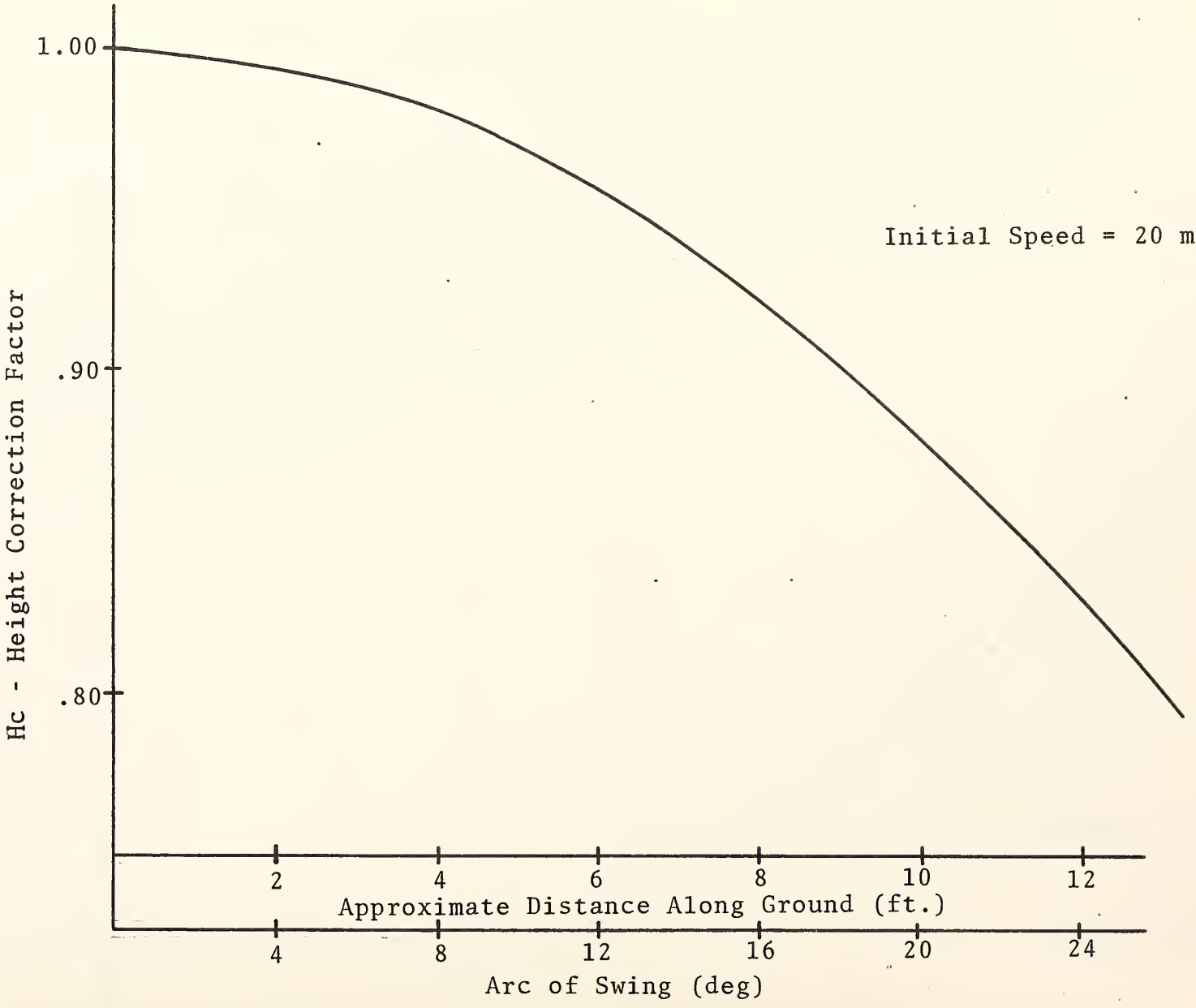


Figure 10. Correction Factor for Speed Transducer

4.0 DESCRIPTION OF TESTS

The tests conducted at the FHWA Impact Test Facility were separated into the following four categories:

Series	Type
000	Steel luminaires with slip bases
100	Aluminum luminaires with shoe bases
200	Dual-legged sign supports (8WF20)
300	Dual-legged sign supports (8WF20) with rigid face pendulum

A description of the support specimen configuration used in each test is given in this section. The Test Request Form, Test Checklist, Data Reduction Sheet, and Acceleration Traces for each test are given in the Appendices.

4.1 STEEL LUMINAIRES WITH SLIP BASES

In the 000 series tests, two types of luminaire supports were tested. Tests 001 through 004 were conducted with a 30-foot slip base steel luminaire support which was 7 inches in diameter at the base and weighed over 250 lbs. The first three tests utilized a "hard" crushable front end, as compared to the standard crush assembly later used in the project. The fourth was a rigid face test designed to determine the momentum change associated with the inertial properties of the pole.

A description of the luminaires used in the 001-004 tests is given in Table 1 together with details of the larger luminaires tested later. Details of the slip base and adapter plate are shown in Figure 11 and 12. The slip bases were fastened to the adapter plates using Hi-Lok Torque Control nuts. A description

Table 1. Description of Steel Slip Base Luminaires

	Luminaire 1	Luminaire 2
TESTS	001-004	005-010
Type of Material	Steel	Steel
Weight of Pole	217 lbs.	360 lbs.
Diameter of Base	7.4 inches	9.0 inches
Length	26.95 feet	33 feet
Radius of gyration	8.5 feet	10.1 feet
Center of gravity (from ground level)	9.8 feet	13.9 feet

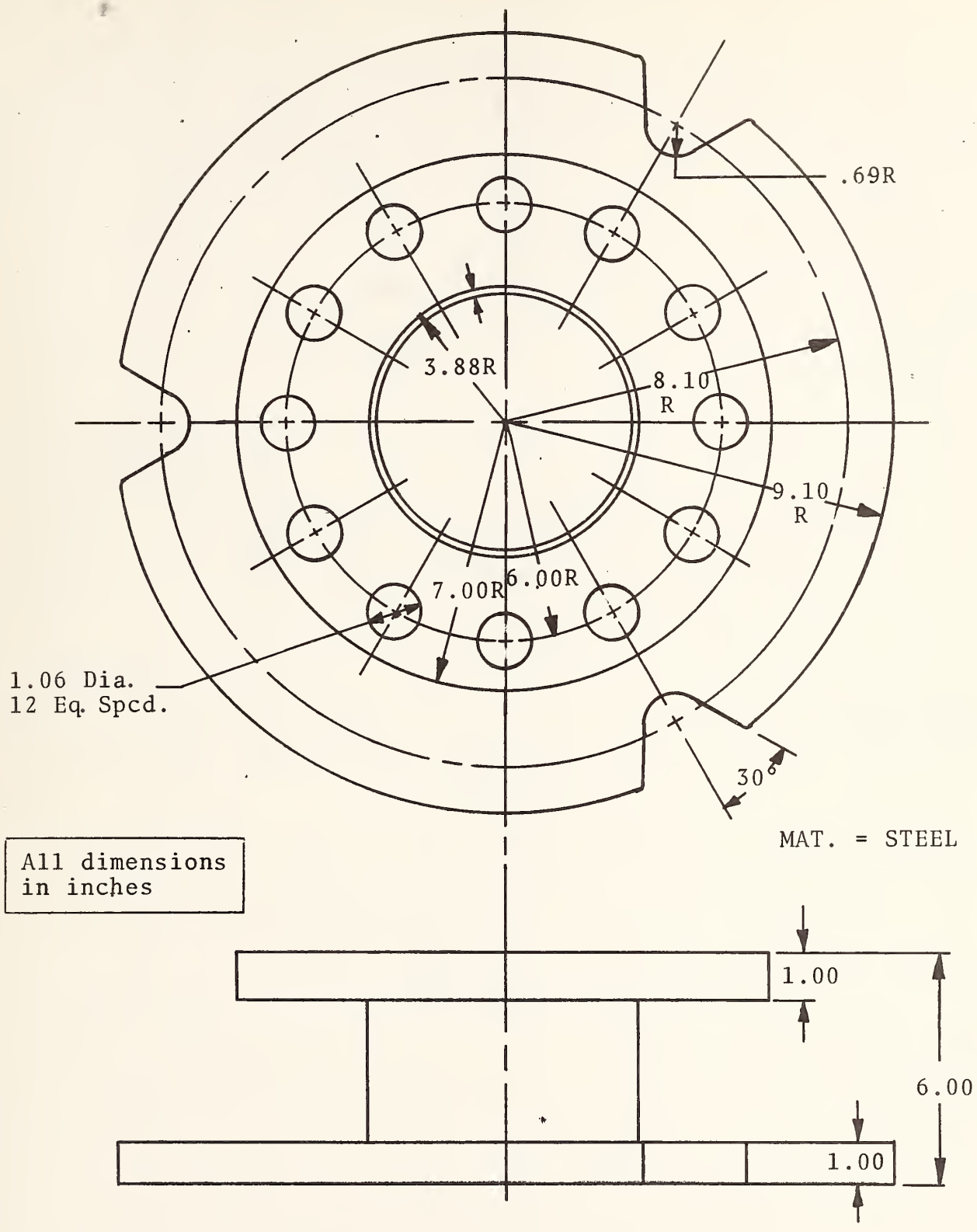


Figure 11. Slip Base for Luminaire Support

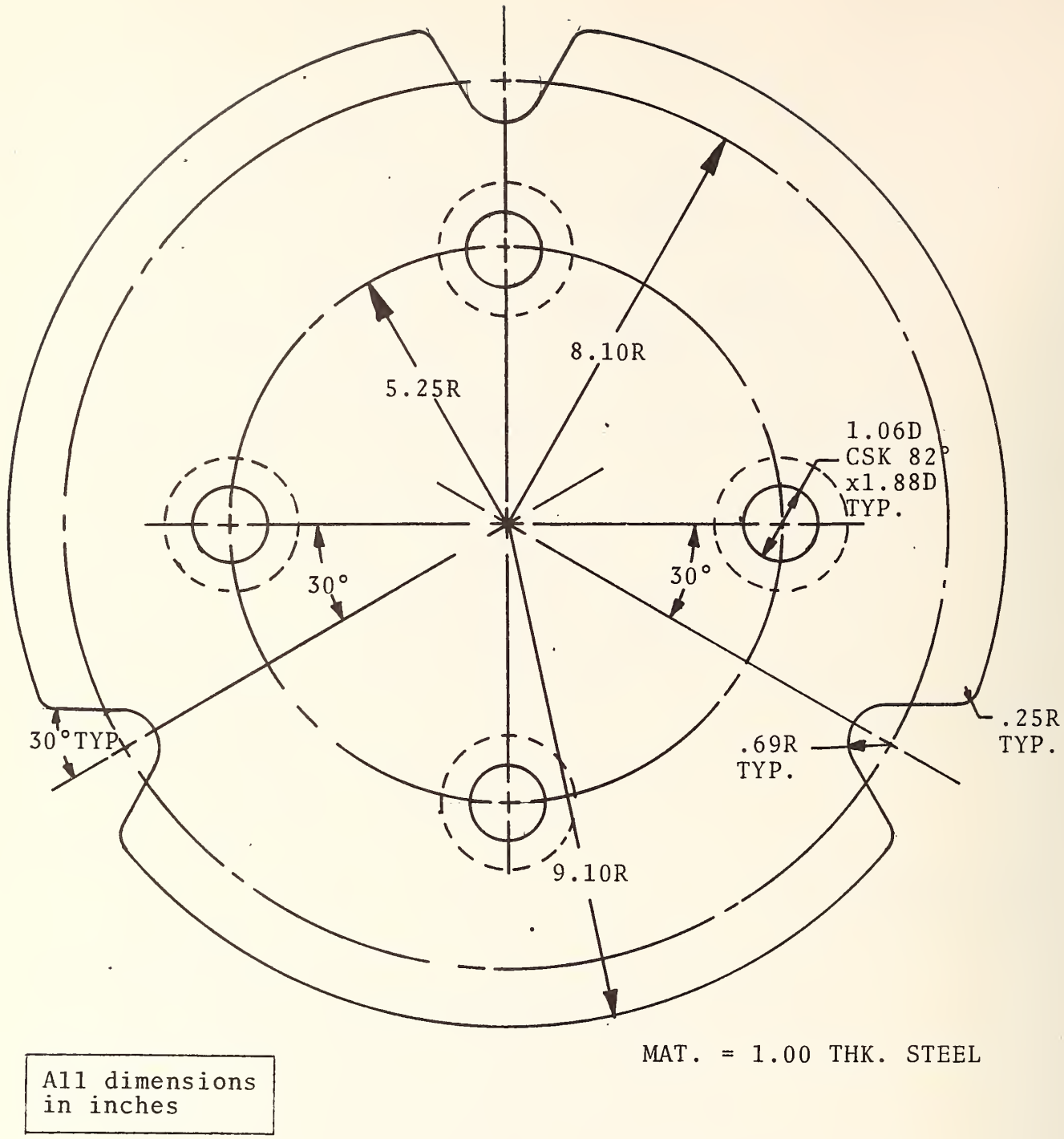


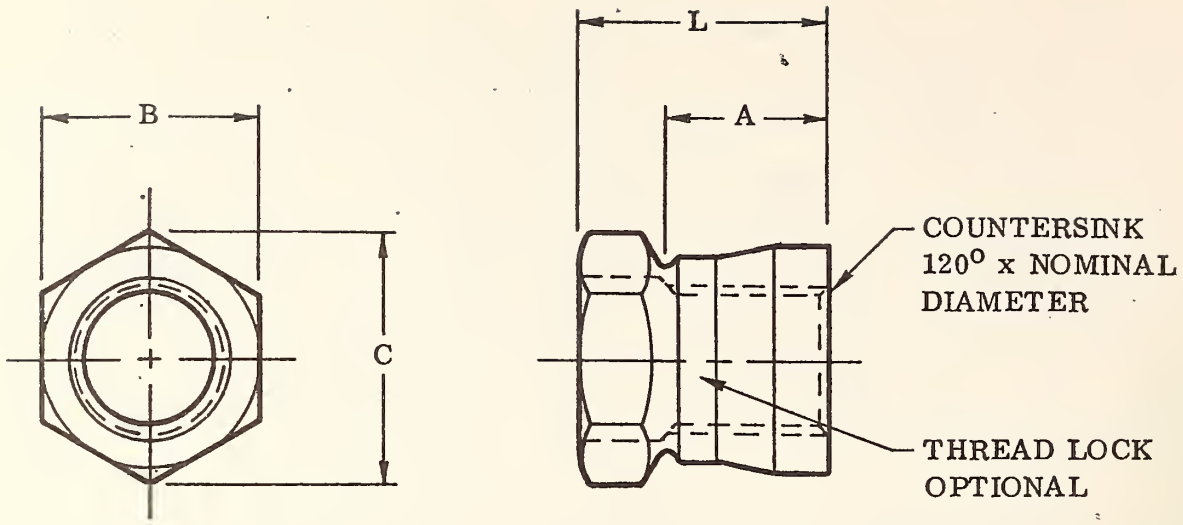
Figure 12. Adapter Plate for Slip Base

of these nuts can be found in Figure 13. Since these nuts cannot be tightened above a certain torque level they provide a fairly constant perload on the bolts. The preload vs. torque for these nuts is shown in Figure 14, where it is shown that the preload (corresponding to the torque-off range) is held between 3000 and 4000 lbs. Regular bolts, on the other hand, besides having no method for controlling torque, exhibit a much more wide variation on the preload for a given torque level thereby giving much less control on the preload.

In tests 005 and 006, a larger steel luminaire support was tested (see Table 1). This support was 9 inches in diameter at the base, 33 feet high, and weighed 360 lbs. These two tests utilized the standard crush assembly. Test 007 used a rigid face pendulum test. These supports again had a multi-directional slip base plate and an adapter similar to the one described in Figures 11 and 12. However, regular bolts and nuts were used in these tests. Using a torque wrench, the base in test 005 was bolted down to 150 ft-lbs. This value was increased to 200 ft-lbs. in test 006.

Tests 008, 009, and 010 also involved the larger luminaire support with the standard crush assembly. In these tests, however, the poles were bolted to the slip base using two other torque settings on the bolt. In tests 008 and 009, the bolts were hand-tightened and then tightened by a wrench one more half-turn. In test 010, the bolts were tightened until "snug" (that is, until good metal-to-metal contact was observed), and then tightened one more half-turn with a wrench.

It maybe noted that in tests 005, 006 and 008-010, the same set of test conditions prevailed, except for the amount of torque on the slip base bolts. The result of these tests is shown graphically in Figure 15. As expected the tests show that momentum



DASH NO.	THREAD SIZE	A	B	C		L (REF.)	TORQUE RANGE INCH-POUNDS ②
-8	1/2-13 UNC	.610 .580	.750 .736	.866 .840		.875	180-220
-10	5/8-11 UNC	.750 .720	.938 .922	1.083 1.051		1.100	410-490
-12	3/4-10 UNC	.910 .880	1.125 1.088	1.299 1.240		1.250	700-800

MATERIAL: Carbon steel.

FINISH: Black oxide and cetyl alcohol lube per Hi-Shear Spec. 305.

CODE: Dash number indicates nominal thread size in 1/16ths.
"L" suffixed to basic number indicates thread lock.

EXAMPLE: CHL14-8 = 1/2-13 Hi-Lok Nut without thread lock.
CHL14L-8 = 1/2-13 Hi-Lok Nut with thread lock.

Figure 13. Details of Torque Control Nuts

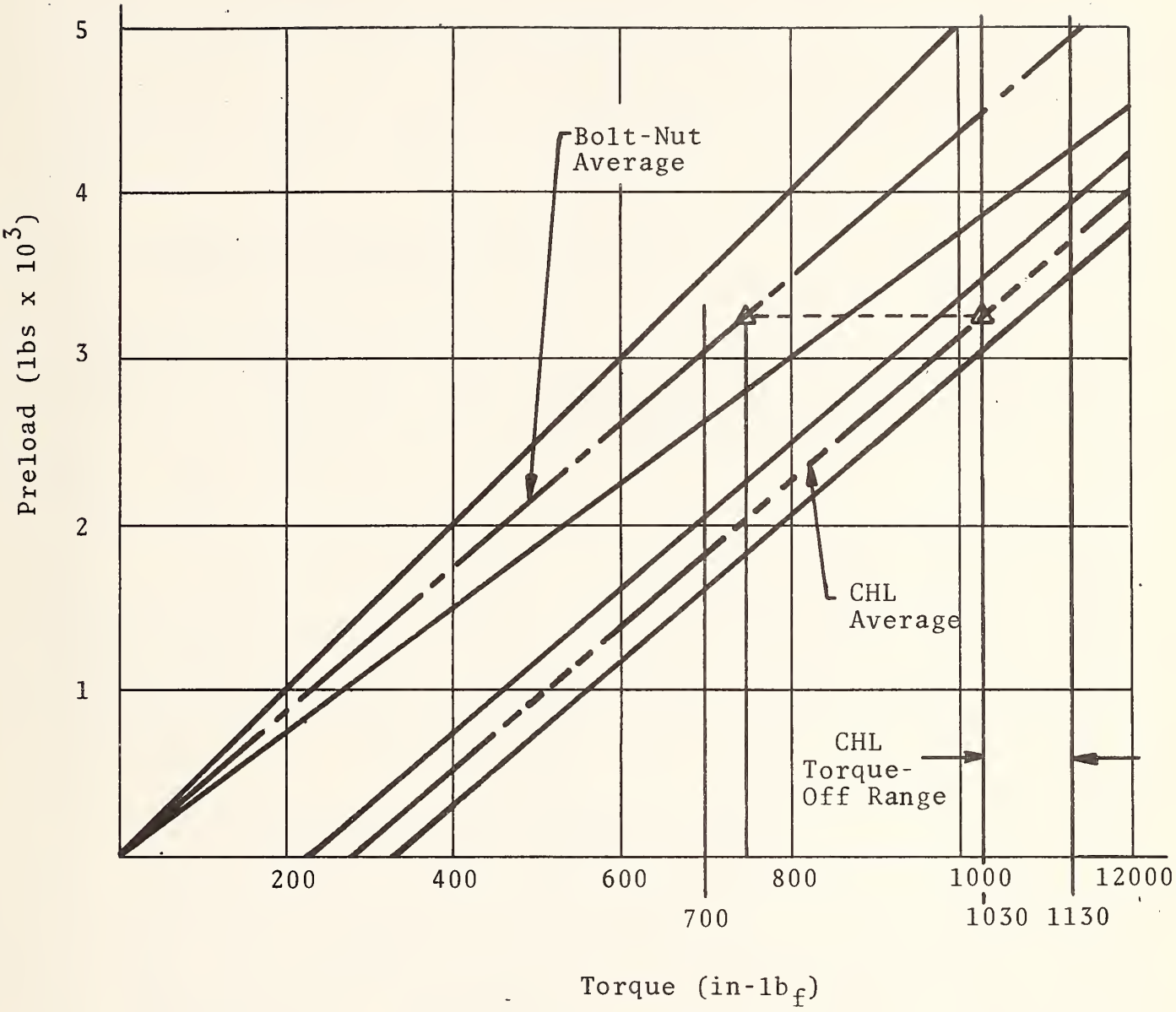


Figure 14. Torque-tension curve for torque control nuts and regular nuts

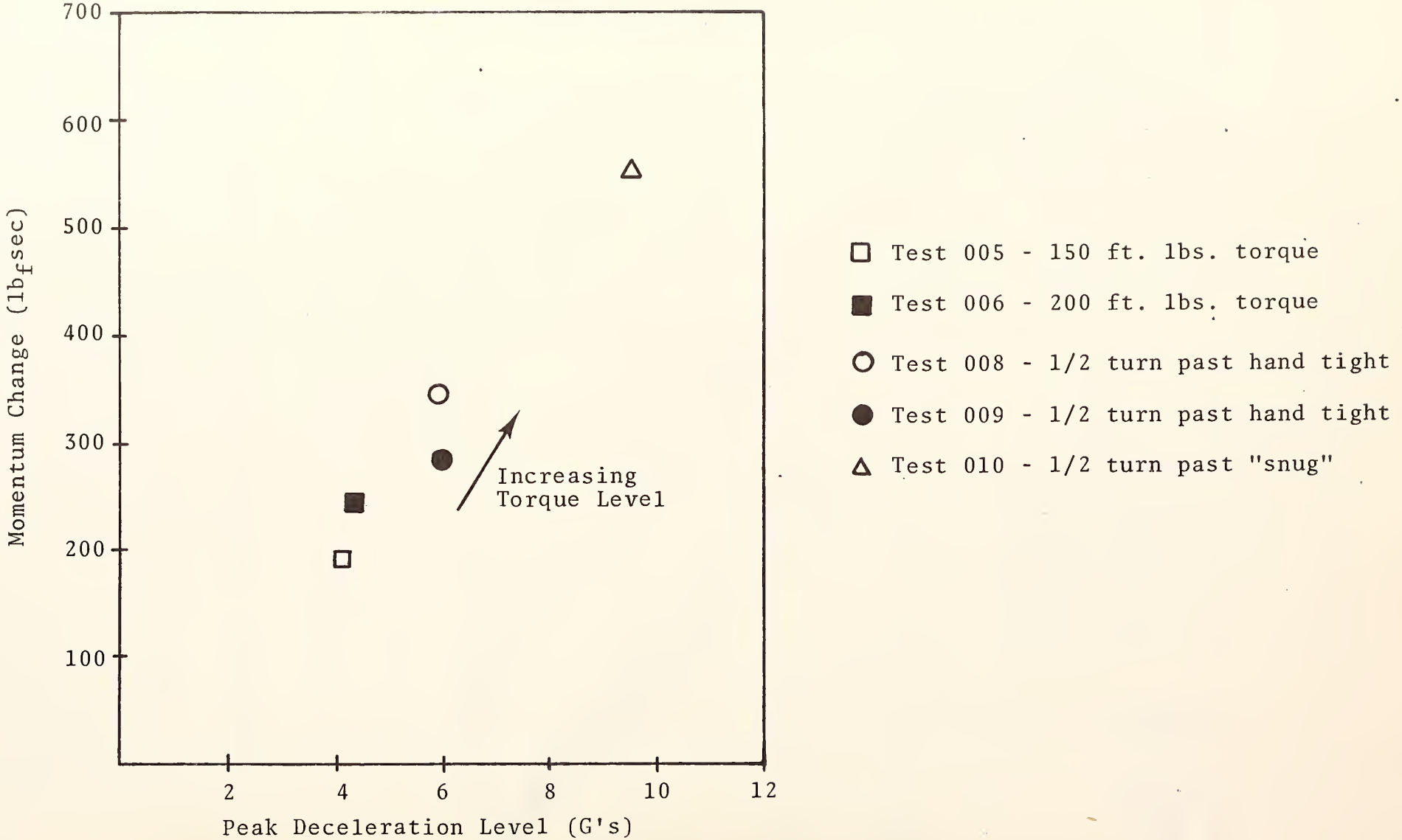


Figure 15. Effect of Torque Level on Momentum Change and Peak Deceleration

change and peak g-level increase with torque level. Thus, if repeatable performance, in terms of momentum change, is desired, the bolt torque level must be carefully controlled.

A summary of the test results for the steel slip base luminaires is given in Section 5.1. The actual test data is given in Appendix A.

4.2 ALUMINUM LUMINAIRES WITH SHOE BASE

Tests 101-104 were conducted using 30-foot aluminum luminaire supports fitted with shoe bases. These supports weigh less than 200 lbs and have a maximum base diameter of 8 inches. A typical configuration of the pole and base is shown in Figure 16. Specifications for the support and base are given in Table 2.

The shoe bases showed various failure modes and were very unrepeatable sometimes causing momentum changes that were beyond the 1100 lb_fsec acceptable limit. A summary of the test results for these aluminum shoe base luminaires is given in Section 5.2. The actual test data is given in Appendix B.

4.3 DUAL-LEGGED SIGN SUPPORT (8WF20) TESTS

Since these tests were the first to be performed at the test facility, their prupose was to standardize a test procdure and isolate any problems that might arise during impact with a breakaway support. This 200 series of tests involved the impact of the pendulum mass into an 8-foot section of an 8WF20 sign support mounted on a slip base. The slip base configuration used is shown in Figure 17. Since the impact only involved an 8 ft section of the sign support it is expected that the momentum change experienced will be less than that due to an impact with the complete sign support system. A summary of the pendulum test results is given in Section 5-3. The actual test data is given in Appendix C.

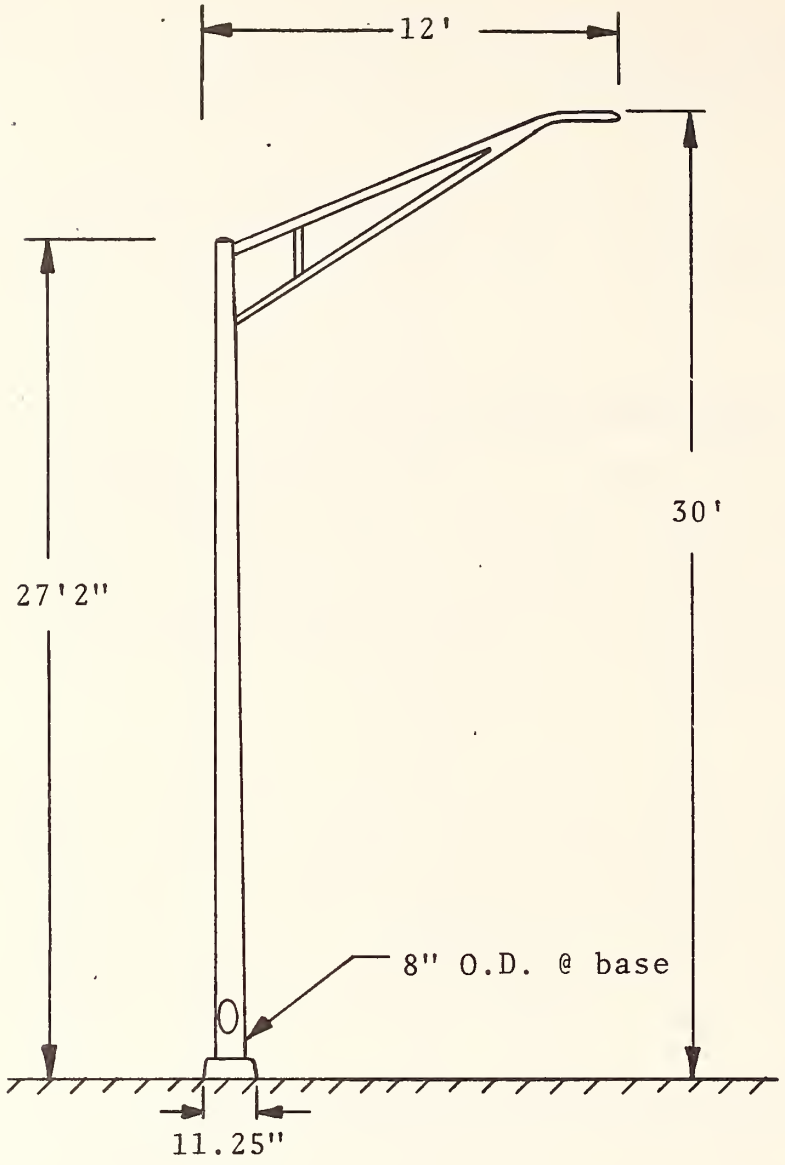


Figure 16. Aluminum Luminaire with Shoe Base

	Luminaire 3
TESTS	101-104
Support Material	Aluminum Alloy 6063-T6 (wall thickness 0.188")
Shoe Base Material	Aluminum Alloy 356-T6
Length	27'2"
Mounting Height	30'
Center of Gravity from ground level	11.6'
Radius of gyration	7.8'
Diameter of base	8"
Weight of support	138 lb.
Weight of luminaire arm	28 lb

Table 2. Description of Aluminum Shoe Base Luminaire

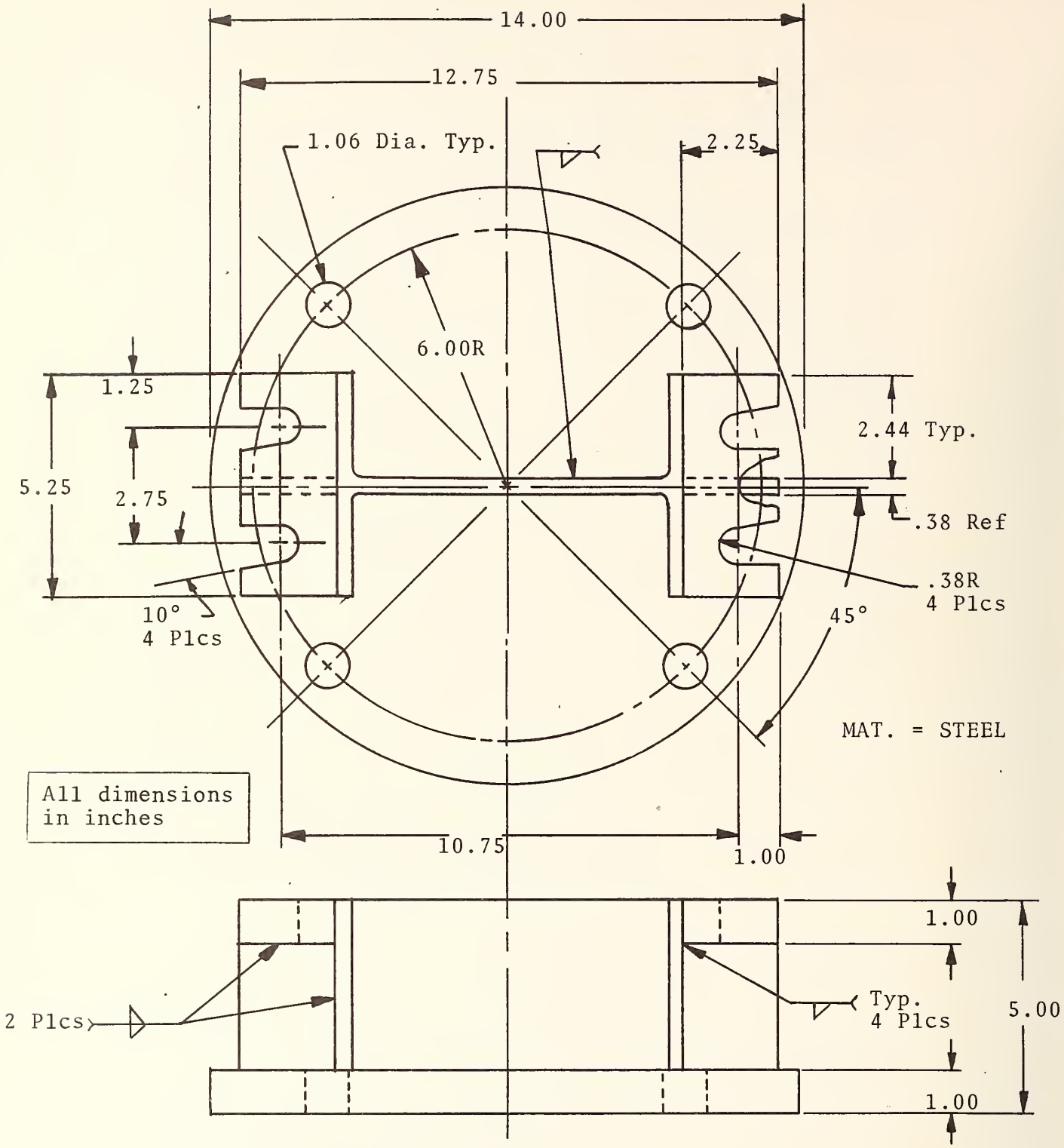


Figure 17. Slip Base for Dual-Legged Sign Support (8WF20)

4.4 DUAL-LEGGED SIGN SUPPORT (8WF20) TESTS WITH RIGID FACED PENDULUM

The 300 series tests again involved the use of 8WF20 sign supports; however, these tests were conducted with a rigid face pendulum and loose base bolts. The primary purpose here was to correlate experimental results with those based on analytical predictions and gain some insight into the momentum change associated with accelerating the support. In these tests, as well as the similar rigid-faced tests with luminaire supports, the force associated with base breakaway and simulated vehicle crush is almost eliminated. Thus the momentum change is caused solely by the inertial properties of the support being impacted.

It may be shown that the analytical momentum change is given by

$$\Delta (MV)_I = \alpha M_p V_0 \frac{R^2}{R^2+D_0^2} \quad (lb_f sec)$$

where α is a constant close to 1. (See report on Task F for more details). The values of the ratio $(R^2/R^2+D_0^2)$ for the various supports and the weights are given in Table 3.

Table 3. Inertial parameters for various supports

	Type of Support	Weight (lbs)	D_0 (ft)	R(ft)	$\frac{R^2}{R^2 + D_0^2}$
○	8'8WF20 I-beam	165	2.2	2.4	0.55
●	16'8WF20 I-beam	325	6.2	4.6	0.36
■	30' Steel Luminaire	266	7.3	8.5	0.55
□	30' Steel Luminaire	360	11.6	9.7	0.44

The graph in Figure 18 shows that the analytically and experimentally obtained results correlate well and that the momentum associated primarily with the initial properties of the support can be predicted accurately.

Some energy was dissipated in the base (slight bolting to prevent premature movements) and in the piece of wood used as a rigid face, which may account for the small differences between analytical predictions and experimental results. A summary of the test results is given in Section 5.5. The actual test data is shown in Appendix C.

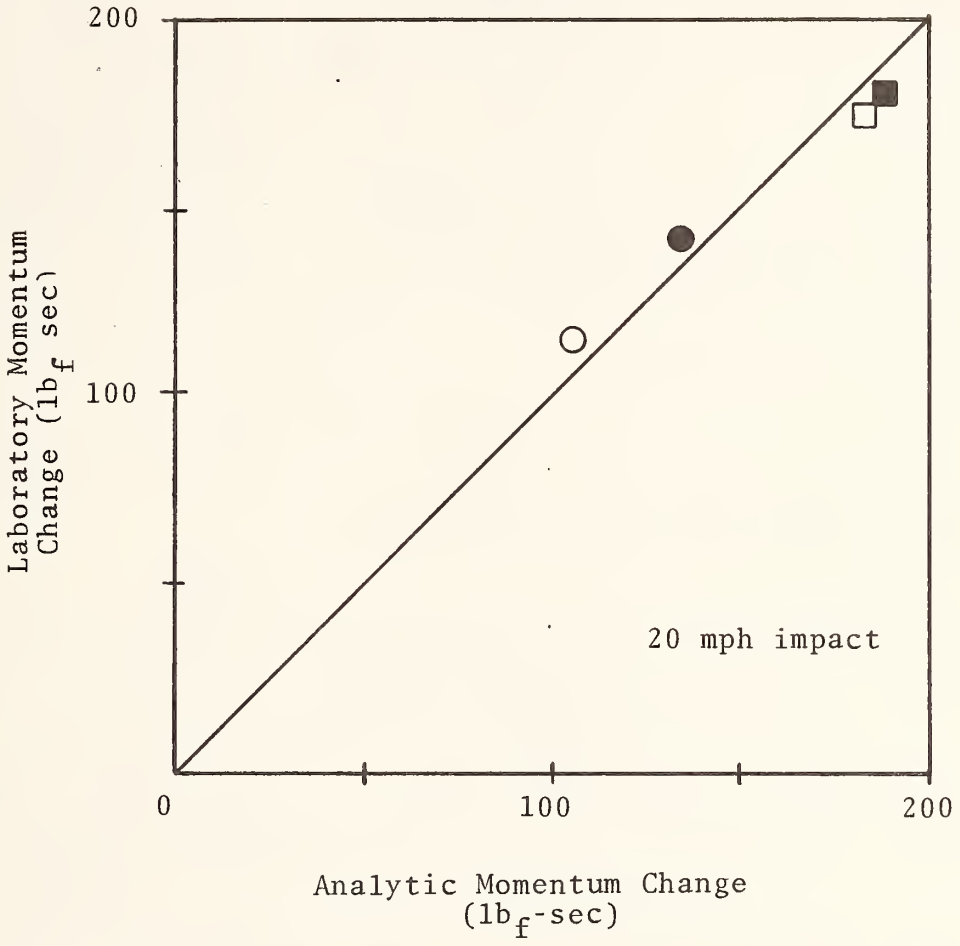


Figure 18. Comparison of analytical and experimental results for momentum change associated with inertial properties of support*

* See Table 4-3 for key to data points.

5.0 SYNOPSIS OF LABORATORY TEST RESULTS

5.1 30 FT STEEL LUMINAIRES WITH SLIP BASES

Test #	Purpose	Crush Characteristics	ΔMV (lb-sec)	Comments
001	Slip Base Luminaire Check. Repeatability	3 Honeycomb Segments (Reg) 130-230-320 psi	220	1 Bad Amplifier F_B = 10 Kips
002	"	2 Segments (Reg) 130-230 psi	202	F_B = 10 Kips
003	"	3 Segments (Reg) 130-230-320 psi	205	With Slip Base F_B = 10 Kips
004	Slip Base Luminaire	Rigid Face No Crush	188	$F_B \cong 0$ 3rd Phase Only

5.2 40 FT STEEL LUMINAIRES WITH SLIP BASES

Test #	Purpose	Crush Characteristics	ΔMV (lb-sec)	Comments
005	Initial Test for	3 Honeycomb Segments 75-130-230 psi (Standard)	194	$F_B \cong$ 5 Kips
006	"	"	237	$F_B \cong$ 8 Kips
007	Slip Base Luminaire	Rigid Face No Crush	174	$F_B \cong 0$ 3rd Phase only
008	Correlate with TTI	Standard 75-130-230	452	$F_B \cong$ 11.7 Kips Turn of the nut method (1/2 turn)
009	"	"	388	$F_B \cong$ 12 Kips 1/2 turn
010	"	"	656	$F_B \cong$ 19 Kips 1/2 turn

5.3 30 FT ALUMINUM LUMINAIRES WITH SHOE BASES

Test #	Purpose	Crush Characteristics	ΔMV (lb-sec)	Comments
101	Correlate with TTI results	3 Honeycomb Seg (Reg) 130-230-320 psi	943	Failed at flanges and at hand hole
102	"	3 Segments (Tapered)* 130-230-320 psi	780	Failed above weld
103	Correlate with TTI Results, Determine Repeatability of Shoe Base Tests	"	1187	Failed above weld & at hand hole
104	"	3 Segments (Tapered)** 230-130-320 (Centered)	1077	Failed at flanges

* 130 psi - 3.2" 230 psi - 4.5" 320 psi - 8"
** 230 psi - 3.2" 130 psi - 4.5" 320 psi - 8"

5.4 DUAL-LEGGED SIGN SUPPORTS (8WF20) WITH SLIP BASES

Test #	Purpose	Crush Characteristics	ΔMV (lb-sec)	Comments
201	8WF20 1st test slip Determine Repeatability	2 Honeycomb Segments 130-230 psi	362	Ringing in Accelerometer
202	8WF20 Test Slip Base	"	326	2 Accelerometers failed
203	"	3 Honeycomb Segments 130-230-320 psi	313	Data Results good
204	"	2 Honeycomb Segments	298	Typical I-Beam Test

5.5 DUAL-LEGGED SIGN SUPPORTS (8WF20) WITH SLIP BASE STRUCK BY RIGID FACE PENDULUM

Test #	Purpose	Crush Characteristics	ΔMV (lb-sec)	Comments
301	Validate Analysis	Rigid Face, No Crush	114	$F_B \cong 0.2$ Accelerometers Limited
302	"	"	116	$F_B \cong 0$
303	"	"	119	$F_B \cong 0$
3-4	Validate Analysis Technique by varying Inertial Characteristics-Phase 3	"	140	$F_B \cong 0$ 16 ft section
305	Validate Analysis Technique - Phases 2 & 3	"	169	$F_B \cong 10$ Kips
306	"	"	155	$F_B \cong 10$ Kips
307	Validate Analysis	"	117	$F_B \cong 0$
308	"	"	112	$F_B \cong 0$
309	Validate Analysis Technique - Phases 2 & 3	"	153	$F_B \cong 10$ Kips

APPENDIX A

TEST DATA FOR STEEL LUMINAIRES WITH SLIP BASES

FHWA/ENSCO IMPACT TEST FACILITY
TEST REQUEST

Test No. 001

Pole/Support Steel Union Metal 30' mounting height

Description of Setup: 30' Luminaire with slip base adapter

Camera: Required yes [X] no [ ]

Film Color [X] B&W [ ]

Min. Speed 500

Max. Speed 1000

Signals to be Recorded:

a. Accelerometers yes [X] no [ ]

b. Strain gauges yes [ ] no [X]

c. Speed transducers yes [ ] no [X]

d. Other None

Crush Characteristics:

Honeycomb	#1	3/16 - .001	130 psi	8"
	#2	1/4 - .001	230 psi	8"
	#3	1/8 - .001	320 psi	8"

Initial Speed: 20 mph

Mass (weight of pendulum mass): 2250 lbs.

Comments: Initial test for luminaire supports

FHWA/ENSCO IMPACT TEST FACILITY

Test No. 001 Date: Oct. 2, 1974 Weather: Good

Personnel Present: JA, RO

1. POWER

Circuit breakers on

1	[X]	2	[X]	3	[X]
4	[X]	8	[X]	10	[X]
11	[X]	13	[X]	14	[X]

2. RELEASE HOOK

Attached [X] Plugged In [X] Switch On [X]

3. ACCELEROMETERS

Mounted Correctly [X]

#1 Connected [X] 15 g's

#2 Connected [X] 50 g's

#3 Connected [X] 15 g's

Mounting Pattern of Pendulum Mass (Viewed from Rear)

[2]

[1] [3]

J-Box Connectors tightened [X]

J-Box Cable connected to Control Box [X]

#1 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

300 gain # 8 channel into Tape Recorder

#2 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

300 gain # 9 channel into Tape Recorder

#3 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

300 gain # 10 channel into Tape Recorder

Note: The DC amplifier did not work during impact

4. SPEED TRANSDUCERS Not used for this test

Connected correctly to reference cell [ ]

Connectors on reference cell correct [ ]

Slots lined up [ ]

Distance between first two _____ ft.

Distance between second two _____ ft.

Distance between sets _____ ft.

Connected correctly to control box [ ]

Control box on [ ]

Cable from RCDR to channel _____ on tape recorder

Cable from #1 to INPUTA on freq. counter [ ]

Frequency counter turned on [ ]

Sensitivity on [ ]

#1 recorded on channel _____

#2 recorded on channel _____

5. CAMERA

PPS Dial 60.0 Mult Switch 10.0

Speed Reducer H Servo Brake L

Drag Brake 30 F Setting 4 Film ASA 80

Light meter reading 15.5 Film Color

Film correct [X] Prism correct [X] Trip switch [X]

Camera on stop [X] Timing light on [X] 100 pulses/sec

Balanced [X] Remote cable on [X] Power cable on [X]

Focus setting —

View portal correct [X]

6. CRUSH CHARACTERISTICS

Honeycomb: #1 3/16 - .001 130 psi

#2 1/4 - .002 230 psi

#3 1/8 - .001 320 psi

7. POLE Type: 30 foot steel luminaire

Set up [X] Torqued exactly [X] Torque _____ ft-lbs.

torque control nut

8. TIMING LINES

Frequency 1 khz Voltage (peak to peak) 10 volts

Recorded on channel 1 input to tape recorder

9. TAPE RECORDER Tape # 001

Speed 60 ips

Start of calibration 350

End of calibration 420 Meter Setting

Start of Test 420

Calibration signals recorded [X]

10. MASS

Weight 2250 lbs.

Correct height [X] Est. initial velocity 20 mph

Accelerometer cables out of danger [X]

11. LAST SECOND ITEMS

Arm control box ☐ Not used

Reset frequency counter ☐

Initial # of Pulses (vis)	-
Initial # of Pulses (rec)	-
Final # of Pulses (rec)	-
Impact meter reading	427
Final meter reading	450
Correction factor for height	-
Amount of crush	3.87"

Remarks:

The fixture for honeycomb was damaged during test. From crush of honeycomb, it appears that this occurred sometime after initial impact.

No crush of pole was noted due to this impact. Previous impact did cause a local dent in pole.

TEST # 001

DATA REDUCTION
FHWA/ENSCO IMPACT TEST FACILITY

1. Speed Transducers

A) Initial pulses — → _____ fps = — mph

B) Final pulses —:Cor. Factor _____ → _____ fps = — mph

Weight of mass = 2250 lbs.

ΔMV = (weight /32.2) x (a-b) lb-sec

= — lb-sec

2. Accelerometers

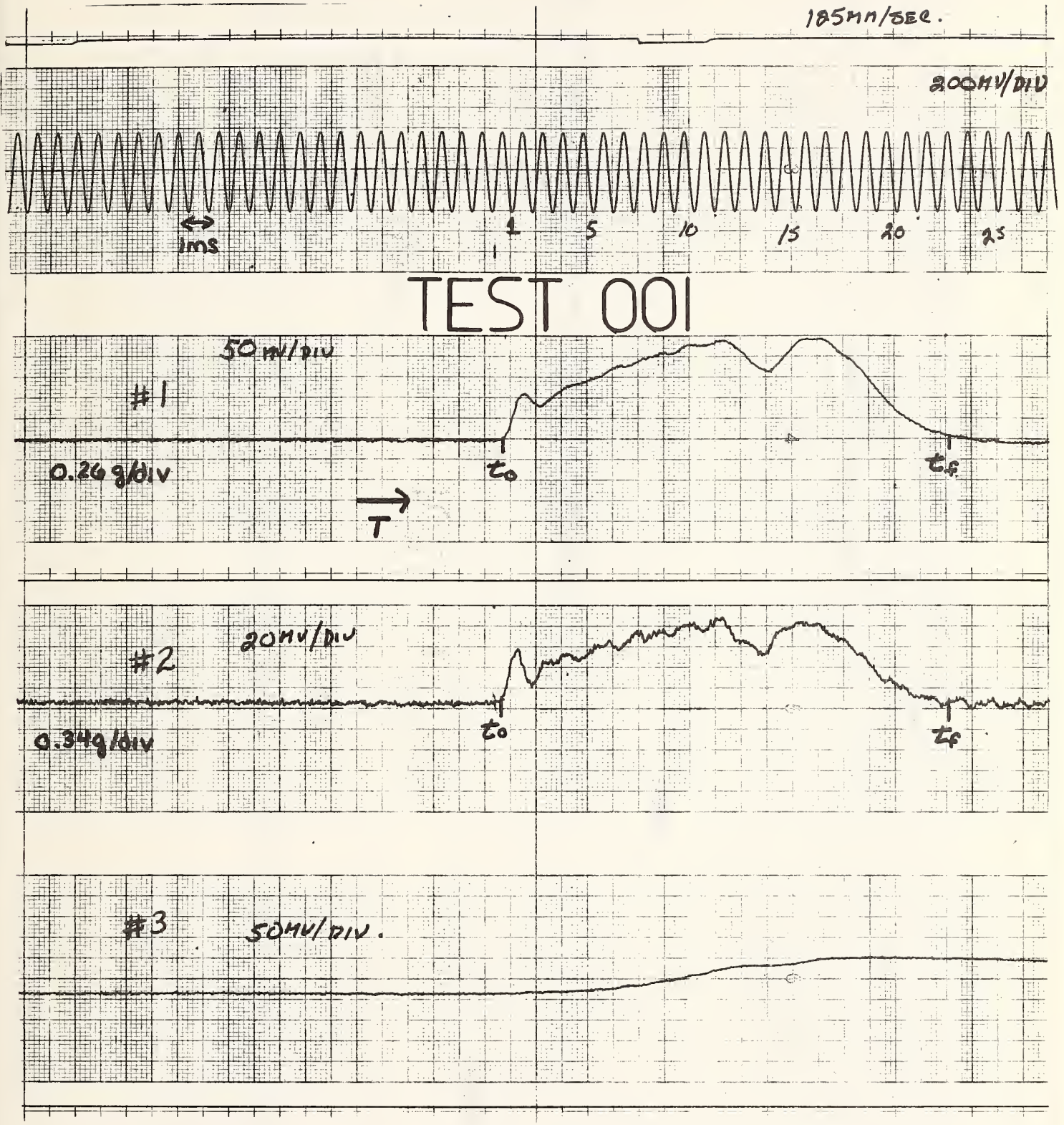
	Area	St. Area	Div.	Cal. Div.	Cal. g's	$\frac{1}{\Delta t}\int_0^{\Delta t} gdt$	Δt	$W\int_0^{\Delta t} gdt$
	1.75	2.64						
#1	1.68	2.68	25	17	4.34	4.12	22.0	204
	1.72	2.66						
	1.500	2.65						
#2	1.56	2.73	25	21	7.20	4.87	22.0	236
	1.53	2.69						
#3				BAD AMPLIFIER				

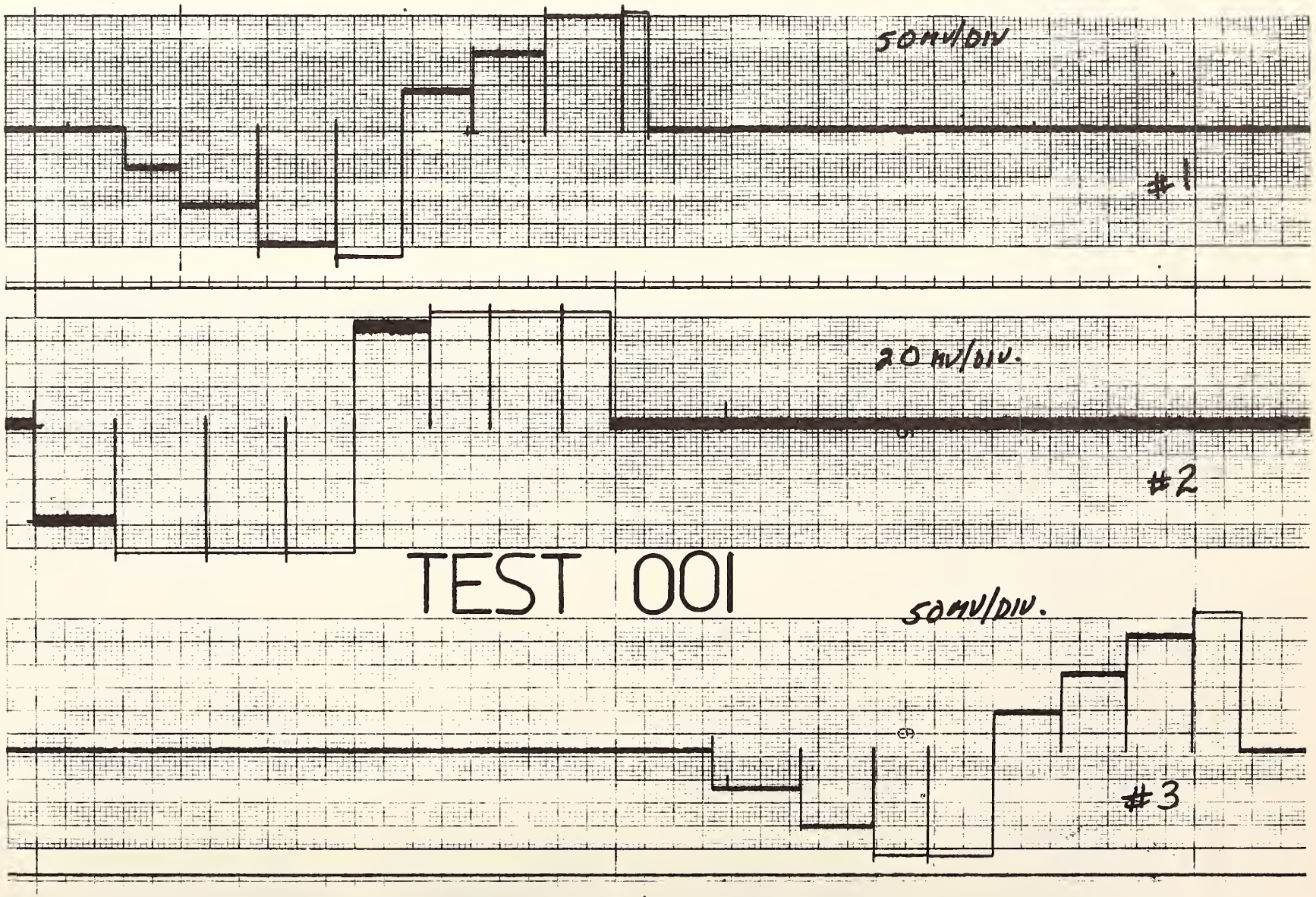
$$\frac{1}{\Delta t}\int_0^{\Delta t} gdt = \frac{\text{Area}}{\text{St. Area}} * \text{Div.} * \frac{\text{Cal. g's}}{\text{Cal. Div.}}$$

$$M\Delta V = W\int_0^{\Delta t} gdt$$

$M\Delta V$ = 220 lb-Sec

DATE 10/3/74 JWA


125MM/SEC.
200MV/DIV
1MS
1
5
10
15
20
25
TEST 001
50 MV/DIV
#1
0.26 g/DIV
t_0
t_f
T
#2
20MV/DIV
0.34g/DIV
t_0
t_f
#3
50MV/DIV.


50MV/DIV
#1
20 MV/DIV.
#2
TEST 001
50MV/DIV.
#3

FHWA/ENSCO IMPACT TEST FACILITY
TEST REQUEST

Test No. 002

Pole/Support 30' luminaire - steel

Description of Setup: slip base with shear pins and Hi-Lok torque bolts

Camera: Required yes [X] no [ ]

Film Color [X] B&W [ ]

Min. Speed 300

Max. Speed -

Signals to be Recorded:

a. Accelerometers yes [X] no [ ]

b. Strain gauges yes [ ] no [X]

c. Speed transducers yes [X] no [ ]

d. Other None

Crush Characteristics:

Honeycomb #1 3/16 - 130 psi 8"

#2 1/4 - 230 psi 8"

#3 —

Initial Speed: 20 mph

Mass (weight of pendulum mass): 2250 lbs.

Comments:

FHWA/ENSCO IMPACT TEST FACILITY

Test No. 002 Date: 10/4/74 Weather: Good

Personnel Present: RO, JWA, KC

1. POWER

Circuit breakers on

1	[X]	2	[X]	3	[X]
4	[X]	8	[X]	10	[X]
11	[X]	13	[X]	14	[X]

2. RELEASE HOOK

Attached [X] Plugged In [X] Switch On [X]

3. ACCELEROMETERS

Mounted Correctly [X]

#1 Connected [X] 15 g's

#2 Connected [X] 50 g's

#3 Connected [X] 15 g's

Mounting Pattern of Pendulum Mass (Viewed from Rear)

[2]

[1] [3]

J-Box Connectors tightened [X]

J-Box Cable connected to Control Box [X]

#1 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

300 gain # 8 channel into Tape Recorder

#2 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

300 gain # 9 channel into Tape Recorder

#3 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

300 gain # 10 channel into Tape Recorder

4. SPEED TRANSDUCERS

Connected correctly to reference cell [X]

Connectors on reference cell correct [X]

Slots lined up [X]

Distance between first two 2 ft.

Distance between second two 2 ft.

Distance between sets 7.7 ft.

Connected correctly to control box [X]

Control box on [X]

Cable from RCDR to channel _____ on tape recorder

Cable from #1 to INPUTA on freq. counter [X]

Frequency counter turned on [X]

Sensitivity on [X]

#1 recorded on channel 2

#2 recorded on channel 3

5. CAMERA

PPS Dial 40 Mult Switch 10

Speed Reducer H Servo Brake L

Drag Brake 30 F Setting 4 Film ASA 80

Light meter reading 14.5 Film Color

Film correct [X] Prism correct [X] Trip switch [X]

Camera on stop [X] Timing light on [X] 100 pulses/sec

Balanced [X] Remote cable on [X] Power cable on [X]

Focus setting 23

View portal correct [X]

6. CRUSH CHARACTERISTICS

Honeycomb: #1 3/16" - 130 psi

#2 1/4" - 230 psi

#3 -

7. POLE Type: 30' steel luminaire

Set up [X] Torqued exactly [X] Torque _____ ft-lbs.

torque control nuts

8. TIMING LINES

Frequency 1 khz Voltage (peak to peak) 10 volts

Recorded on channel 1 input to tape recorder

9. TAPE RECORDER Tape # 001

Speed 60 ips

Start of calibration 600

End of calibration 694 } Meter Setting

Start of Test 694

Calibration signals recorded [X]

10. MASS

Weight 2250 lbs.

Correct height [X] Est. initial velocity 20 mph

Accelerometer cables out of danger [X]

11. LAST SECOND ITEMS

Arm control box [X]

Reset frequency counter [X]

Initial # of Pulses (vis)	-
Initial # of Pulses (rec)	-
Final # of Pulses (rec)	-
Impact meter reading	701
Final meter reading	730
Correction factor for height	-
Amount of crush	4.12"

Remarks:

TEST # 002

DATA REDUCTION
FHWA/ENSCO IMPACT TEST FACILITY

1. Speed Transducers

A) Initial pulses ___-___ → _____ fps = ___-___ mph

B) Final pulses ___-___ :Cor. Factor _____ → _____ fps = ___-___ mph

Weight of mass = 2250 lbs.

ΔMV = (weight /32.2) x (a-b) lb-sec

= ___-___ lb-sec

2. Accelerometers

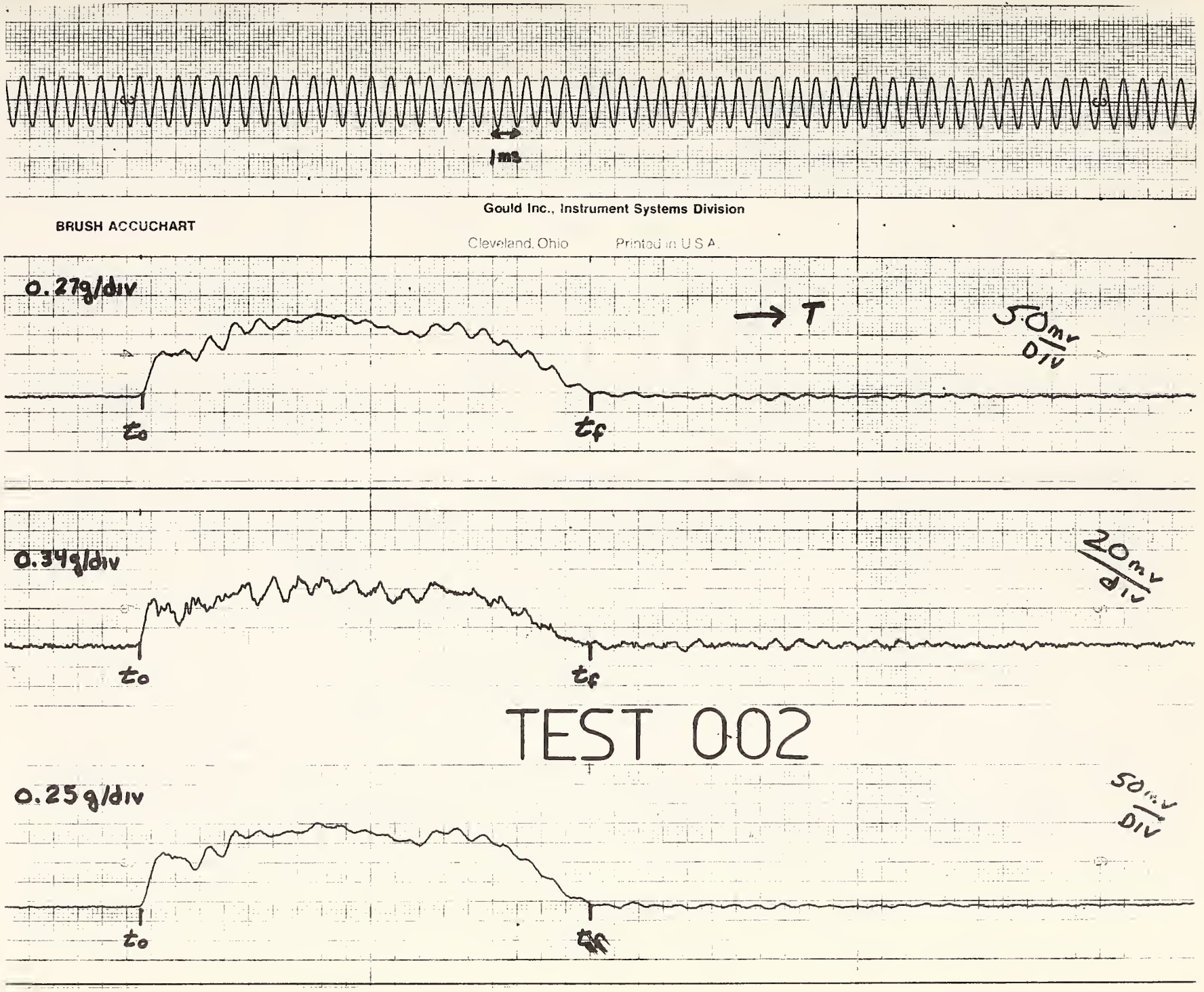
	Area	St. Area	Div.	Cal. Div.	Cal. g's	$\frac{1}{\Delta t}\int_0^{\Delta t} gdt$	Δt	$W\int_0^{\Delta t} gdt$
	1.695	4.14						
#1	1.670	4.06	36	8	2.16	3.99	23.5	211
	1.683	4.10						
	1.320	4.23						
#2	1.305	4.19	35	21	7.20	3.74	23.0	194
	1.312	4.21						
	1.695	4.05						
#3	1.720	3.97	36	8.5	2.13	3.85	23.2	201
	1.708	4.02						

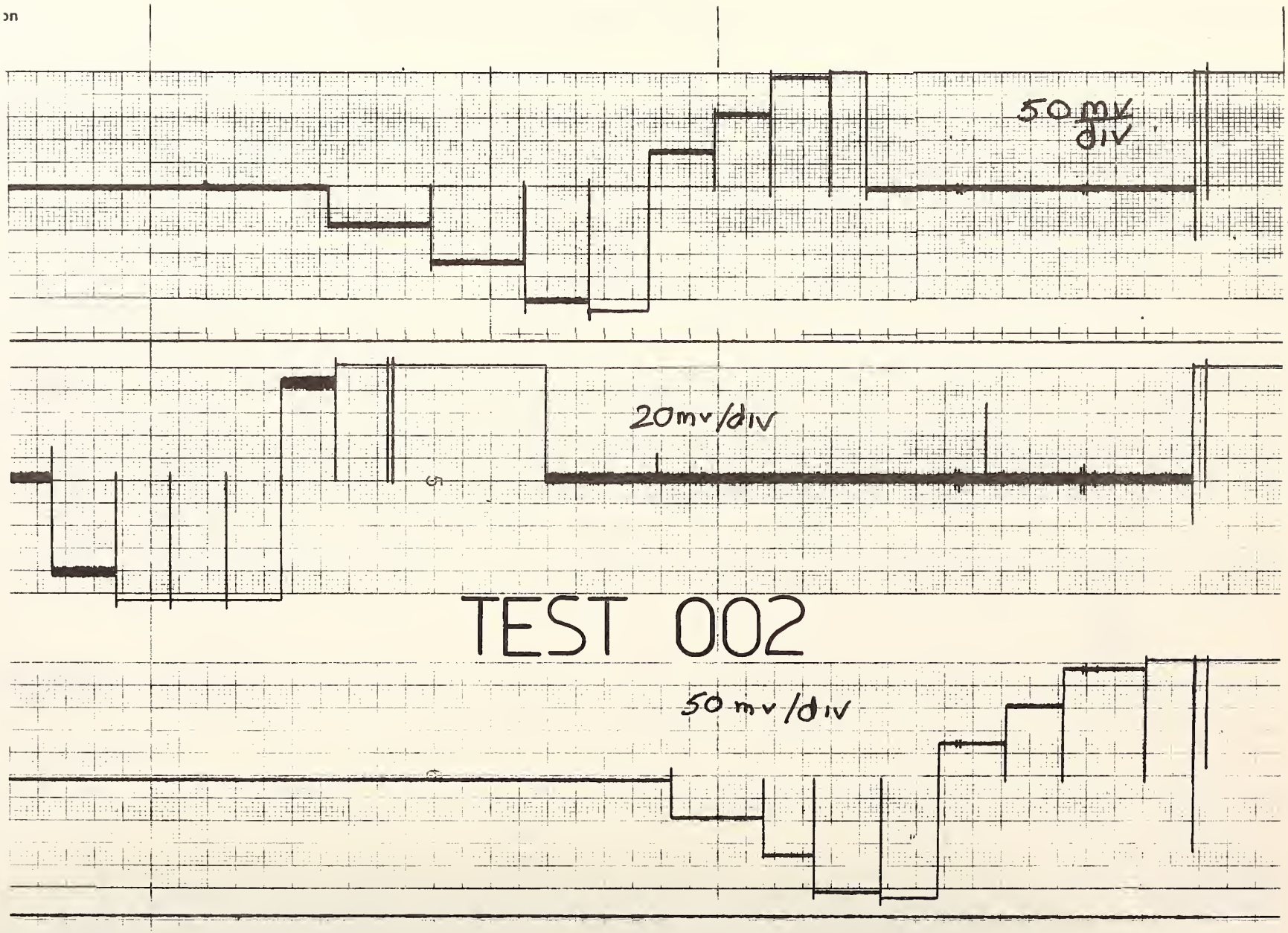
$$\frac{1}{\Delta t}\int_0^{\Delta t} gdt = \frac{\text{Area}}{\text{St. Area}} * \text{Div.} * \frac{\text{Cal. g's}}{\text{Cal. Div.}}$$

$M\Delta V = 202$ (lb-sec)

$$M\Delta V = W\int_0^{\Delta t} gdt$$

DATE 10/7/74 JWA


1ms
BRUSH ACCUCHART
Gould Inc., Instrument Systems Division
Cleveland, Ohio
Printed in U.S.A.
0.27g/div
T
50mv/DIV
t_o
t_f
0.34g/div
20mv/DIV
t_o
t_f
TEST 002
0.25g/div
50mv/DIV
t_o
t_f


50 mv/div
20mv/div
TEST 002
50 mv/div

FHWA/ENSCO IMPACT TEST FACILITY
TEST REQUEST

Test No. 003

Pole/Support 27' steel luminaire

Description of Setup: Slip base adaptor with Hi-Lok Torque bolts

Camera: Required yes [X] no [ ]

Film Color [X] B&W [ ]

Min. Speed 200

Max. Speed

Signals to be Recorded:

a. Accelerometers yes [X] no [ ]

b. Strain gauges yes [ ] no [X]

c. Speed transducers yes [X] no [ ]

d. Other None

Crush Characteristics:

Honeycomb #1 .3/16" - 130 psi 8"

#2 1/4" - 230 psi 8"

#3 1/8" - 320 psi 8"

Initial Speed: 20 mph

Mass (weight of pendulum mass): 2250 lbs.

Comments:

FHWA/ENSCO IMPACT TEST FACILITY

Test No. 003 Date: 10/8/74 Weather: Good

Personnel Present: RO, JWA, KC, GK

1. POWER

Circuit breakers on

1	[X]	2	[X]	3	[X]
4	[X]	8	[X]	10	[X]
11	[X]	13	[X]	14	[X]

2. RELEASE HOOK

Attached [X] Plugged In [X] Switch On [X]

3. ACCELEROMETERS

Mounted Correctly [X]

#1 Connected [X] 15 g's

#2 Connected [X] 50 g's

#3 Connected [X] 15 g's

Mounting Pattern of Pendulum Mass (Viewed from Rear)

[2]

[1] [3]

J-Box Connectors tightened [X]

J-Box Cable connected to Control Box [X]

#1 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

300 gain # 8 channel into Tape Recorder

#2 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

300 gain # 9 channel into Tape Recorder

#3 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

300 gain # 10 channel into Tape Recorder

4. SPEED TRANSDUCERS

First speed transducer too close to pole

Connected correctly to reference cell [X]

Connectors on reference cell correct [X]

Slots lined up [X]

Distance between first two 2 ft.

Distance between second two 2 ft.

Distance between sets 7 ft.

Connected correctly to control box [X]

Control box on [X]

Cable from RCDR to channel — on tape recorder

Cable from #1 to INPUTA on freq. counter [X]

Frequency counter turned on [X]

Sensitivity on [X]

#1 recorded on channel 2

#2 recorded on channel 3

5. CAMERA

PPS Dial 40 Mult Switch x10

Speed Reducer H Servo Brake L

Drag Brake 30 F Setting 4 Film ASA 80

Light meter reading 14 Film Color

Film correct [X] Prism correct [X] Trip switch [X]

Camera on stop [X] Timing light on [X] 100 pulses/sec

Balanced [X] Remote cable on [X] Power cable on [X]

Focus setting -

View portal correct [X]

6. CRUSH CHARACTERISTICS

Honeycomb: #1 130 psi 3/16"

#2 230 psi 1/4"

#3 320 psi 1/8"

7. POLE Type: 30' steel luminaire

Set up [X] Torqued exactly [X] Torque ___ ___ ft-lbs.
torque control nut

8. TIMING LINES

Frequency 1 khz Voltage (peak to peak) 10 volts

Recorded on channel 1 input to tape recorder

9. TAPE RECORDER Tape # 001

Speed 60 ips

Start of calibration 100

End of calibration 138 Meter Setting

Start of Test 140

Calibration signals recorded [X]

10. MASS

Weight 2250 lbs.

Correct height [X] Est. initial velocity 20 mph

Accelerometer cables out of danger [X]

11. LAST SECOND ITEMS

Arm control box [X]

Reset frequency counter [X]

Initial # of Pulses (vis)	1294
Initial # of Pulses (rec)	1101
Final # of Pulses (rec)	1293
Impact meter reading	-
Final meter reading	154
Correction factor for height	.93
Amount of crush	3.5"

Remarks:

TEST # 003

DATA REDUCTION
FHWA/ENSCO IMPACT TEST FACILITY

1. Speed Transducers

A) Initial pulses 1065 → 29.34 fps = 20 mph ≅ 20 mph

B) Final pulses 1293 :Cor. Factor .932 → 25.92 fps = 17.67 mph

Weight of mass = 2250 lbs.

ΔMV = (weight /32.2) x (a-b) lb-sec

= 238.98 lb-sec (?)

2. Accelerometers

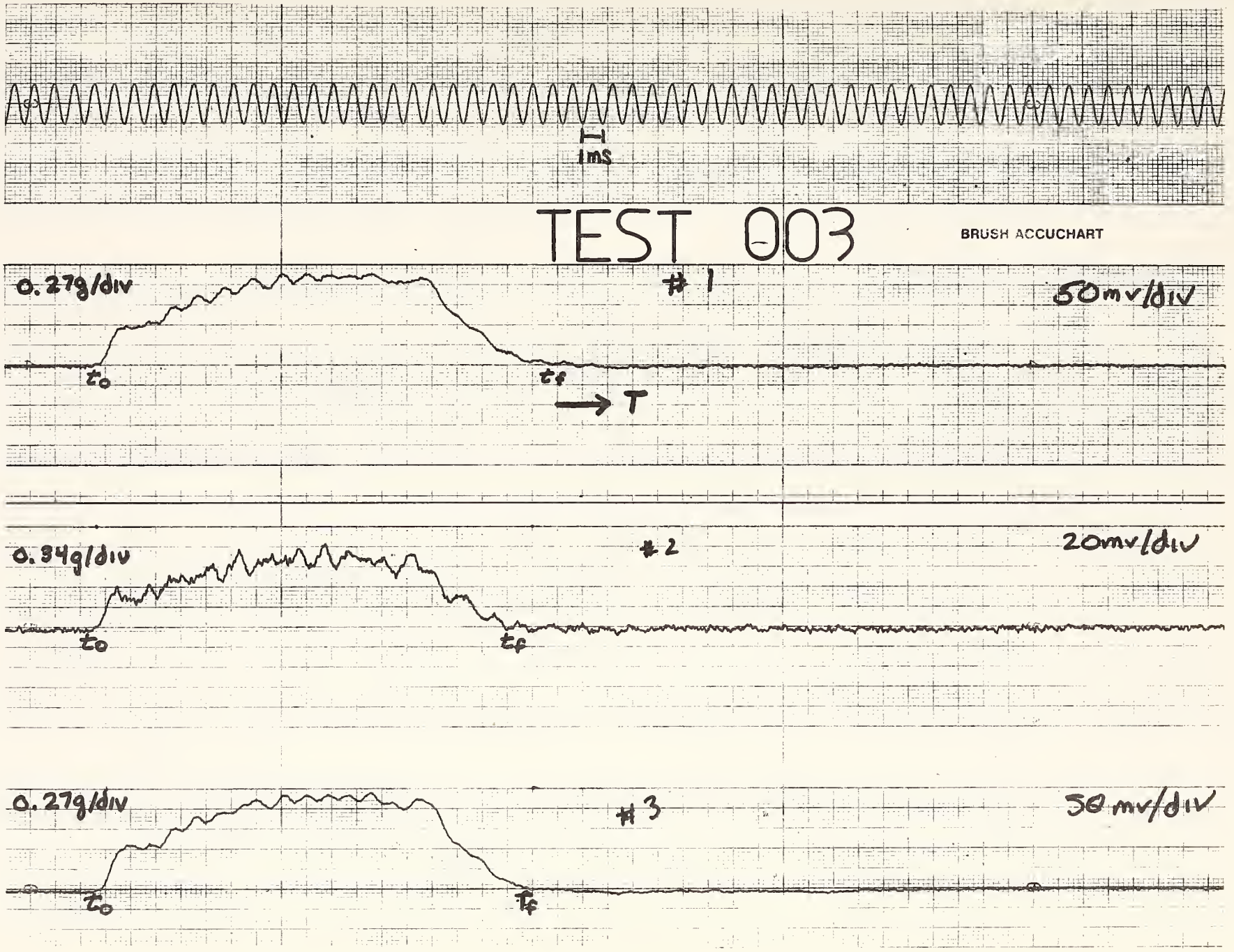
	Area	St. Area	Div.	Cal. Div.	Cal. g's	$\frac{1}{\Delta t}\int_0^{\Delta t} gdt$	Δt	$W\int_0^{\Delta t} gdt$
	1.71	2.73						
#1	1.64	2.70	25	16	4.34	4.17	22	206
	1.67	2.71						
	1.305	2.76						
#2	1.305	2.79	26	21	7.20	4.10	22	202
	1.30	2.775						
	1.80	2.76						
#3	1.67	2.70	25	16	4.27	4.20	22	208
	1.73	2.73						

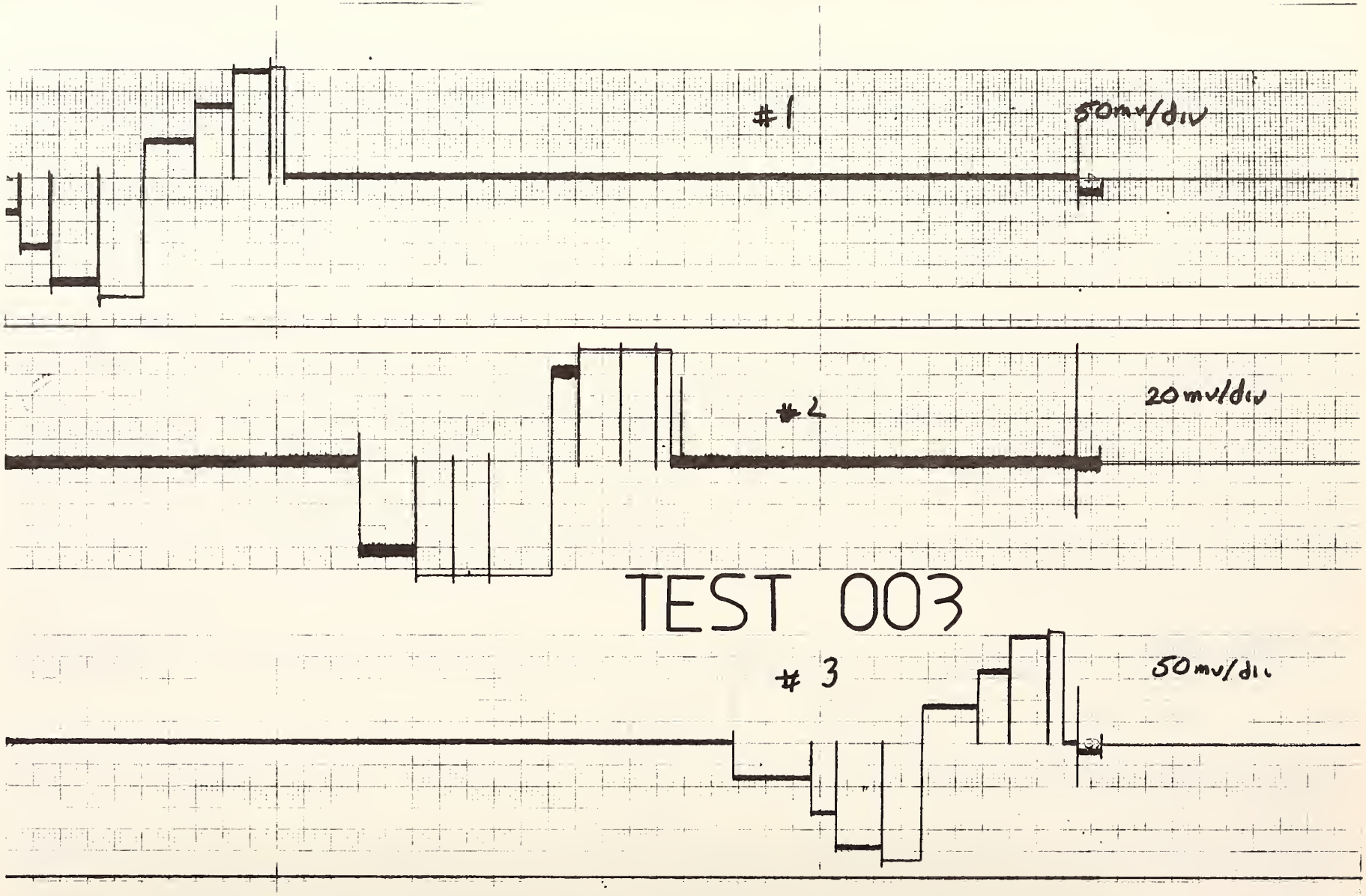
$$\frac{1}{\Delta t}\int_0^{\Delta t} gdt = \frac{\text{Area}}{\text{St. Area}} * \text{Div.} * \frac{\text{Cal. g's}}{\text{Cal. Div.}}$$

$M\Delta V = 205$ lb-Sec

$$M\Delta V = W\int_0^{\Delta t} gdt$$

DATE 10/8/74 JWA


1ms
TEST 003
BRUSH ACCUCHART
0.27g/div
#1
50mv/div
t_o
t_f
T
0.34g/div
#2
20mv/div
t_o
t_f
0.27g/div
#3
50mv/div
t_o
t_f


#1
50mv/div
#2
20mv/div
TEST 003
#3
50mv/div

FHWA/ENSCO IMPACT TEST FACILITY
TEST REQUEST

Test No. 004

Pole/Support 30' steel luminaire

Description of Setup: No torque → F(Base) = 0
RIGID FACE TEST

Camera: Required yes [ ] no [X]

Film Color [ ] B&W [ ]

Min. Speed _____

Max. Speed _____

Signals to be Recorded:

a. Accelerometers yes [X] no [ ]

b. Strain gauges yes [ ] no [X]

c. Speed transducers yes [ ] no [X]

d. Other _____

Crush Characteristics:

Honeycomb #1 _____

#2 N/A

#3 _____

Initial Speed: 20 MPH

Mass (weight of pendulum mass): 2250 lbs.

Comments: _____

FHWA/ENSCO IMPACT TEST FACILITY

Test No. 004 Date: 3/27/75 Weather: Cold

Personnel Present: JWA, RPO

1. POWER

Circuit breakers on

1	[X]	2	[X]	3	[X]
4	[X]	8	[X]	10	[X]
11	[X]	13	[X]	14	[X]

2. RELEASE HOOK

Attached [X] Plugged In [X] Switch On [X]

3. ACCELEROMETERS

Mounted Correctly [X]

#1 Connected [X] 15 g's

#2 Connected [X] 50 g's

#3 Connected [X] 15 g's

Mounting Pattern of Pendulum Mass (Viewed from Rear)

[2]

[1] [3]

J-Box Connectors tightened [X]

J-Box Cable connected to Control Box [X]

#1 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

100 gain # 8 channel into Tape Recorder

#2 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

300 gain # 9 channel into Tape Recorder

#3 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

100 gain # 10 channel into Tape Recorder

4. SPEED TRANSDUCERS (N/A)

Connected correctly to reference cell [ ]

Connectors on reference cell correct [ ]

Slots lined up [ ]

Distance between first two _____ ft.

Distance between second two _____ ft.

Distance between sets _____ ft.

Connected correctly to control box [ ]

Control box on [ ]

Cable from RCDR to channel _____ on tape recorder

Cable from #1 to INPUTA on freq. counter [ ]

Frequency counter turned on [ ]

Sensitivity on [ ]

#1 recorded on channel _____

#2 recorded on channel _____

5. CAMERA (N/A)

PPS Dial _____ Mult Switch _____

Speed Reducer _____ Servo Brake _____

Drag Brake _____ F Setting _____ Film ASA _____

Light meter reading _____ Film _____

Film correct ☐ Prism correct ☐ Trip switch ☐

Camera on stop ☐ Timing light on ☐ _____pulses/sec

Balanced ☐ Remote cable on ☐ Power cable on ☐

Focus setting _____

View portal correct ☐

6. CRUSH CHARACTERISTICS

Honeycomb: #1 N/A

#2 _____

#3 _____

7. POLE Type: 30' steel luminaire

Set up [X] Torqued exactly [X] Torque ≈0 ft-lbs.

8. TIMING LINES

Frequency 1 khz Voltage (peak to peak) 10 volts

Recorded on channel 1 input to tape recorder

9. TAPE RECORDER Tape # 001A

Speed 60 ips

Start of calibration 460

End of calibration 499 Meter Setting

Start of Test 499

Calibration signals recorded [X]

10. MASS

Weight 2250 lbs.

Correct height [X] Est. initial velocity 20 mph

Accelerometer cables out of danger [X]

11. LAST SECOND ITEMS

Arm control box ☐

Reset frequency counter ☐

Initial # of Pulses (vis)	-
Initial # of Pulses (rec)	-
Final # of Pulses (rec)	-
Impact meter reading	519
Final meter reading	-
Correction factor for height	-
Amount of crush	-

Remarks:

TEST # 004

DATA REDUCTION
FHWA/ENSCO IMPACT TEST FACILITY

1. Speed Transducers (N/A)

A) Initial pulses _____ → _____ fps = _____ mph

B) Final pulses _____ :Cor. Factor _____ → _____ fps = _____ mph

Weight of mass = _____ lbs.

ΔMV = (weight /32.2) x (a-b) lb-sec

= _____ lb-sec

2. Accelerometers

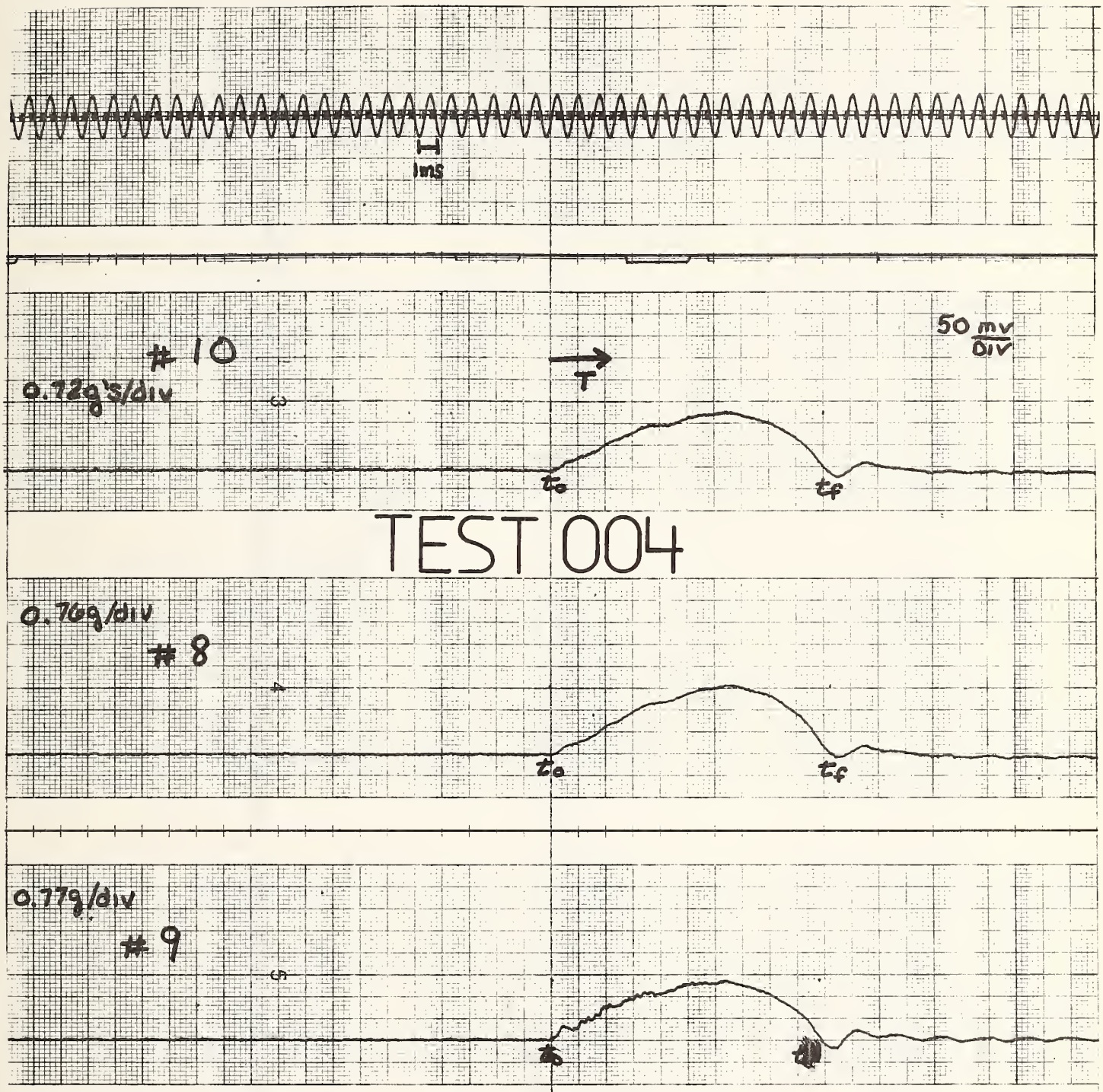
	Area	St. Area	Div.	Cal. Div.	Cal. g's	$\frac{1}{\Delta t}\int_0^{\Delta t} gdt$	Δt	$W\int_0^{\Delta t} gdt$
	38	73						
#1	42	70	15	12	8.64	6.1	13	178
	40	71						
	38	62						
#2	42	63	14	19	14.46	6.7	13.1	199
	40	63						
	38	60						
#3	36	65	14	11	8.52	6.4	13	186
	37	63						

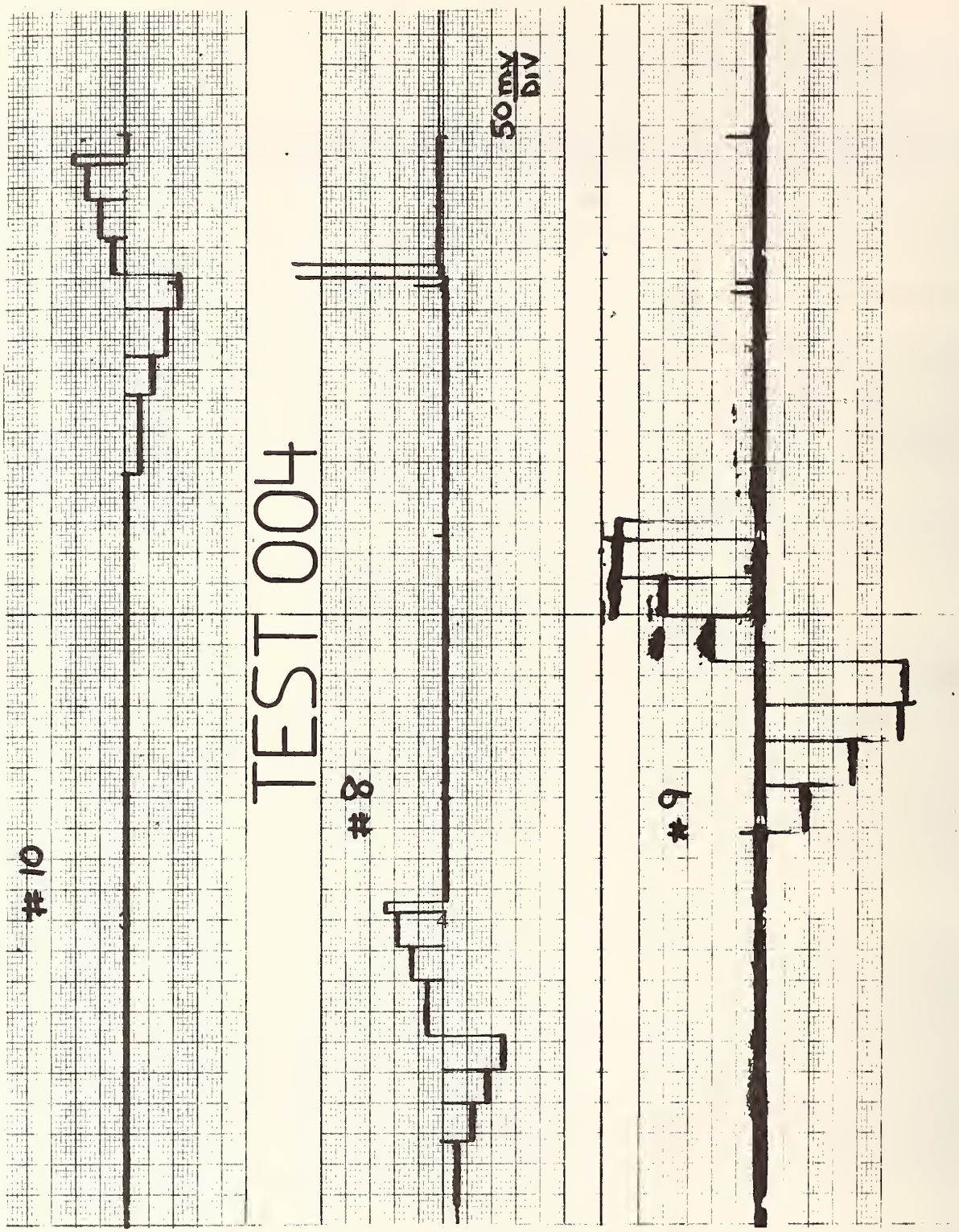
$$\frac{1}{\Delta t}\int_0^{\Delta t} gdt = \frac{\text{Area}}{\text{St. Area}} * \text{Div.} * \frac{\text{Cal. g's}}{\text{Cal. Div.}}$$

$M\Delta V = 188$ lb-Sec

$$M\Delta V = W\int_0^{\Delta t} gdt$$

DATE 3/30/75 JWA


1ms
#10
0.72g's/div
50 mv/div
T
t_o
t_f
TEST 004
0.76g/div
#8
t_o
t_f
0.77g/div
#9
t_o
t_f


TEST 004
50 mv/div
#10
#8
#9
#1
#2
#3

FHWA/ENSCO IMPACT TEST FACILITY
TEST REQUEST

Test No. 005

Pole/Support 33'6" Steel Luminaire (Union Metal)

Description of Setup: Slip base (multi directional)
CUT HONEYCOMB TO SIZE

Camera: Required yes [X] no [ ]

Film Color [ ] B&W [X]

Min. Speed 400

Max. Speed 800

Signals to be Recorded:

a. Accelerometers yes [X] no [ ]

b. Strain gauges yes [ ] no [X]

c. Speed transducers yes [X] no [ ]

d. Other _____

Crush Characteristics:

Honeycomb #1 75 psi 6"22 Vertical Dimension

#2 130 psi 6"22

#3 230 psi 6"22

Initial Speed: 20 mph

Mass (weight of pendulum mass): 2275 lbs.

Comments: Torque bolts to 150 ft-lbs.

#1

#2

#3

FHWA/ENSCO IMPACT TEST FACILITY

Test No. 005 Date: June 24, 1975 Weather: Good

Personnel Present: R.O., J.A., L.M., H.T.

1. POWER

Circuit breakers on

1	[X]	2	[X]	3	[X]
4	[X]	8	[X]	10	[X]
11	[X]	13	[X]	14	[X]

2. RELEASE HOOK

Attached [X] Plugged In [X] Switch On [X]

3. ACCELEROMETERS

Mounted Correctly [X]

#1 Connected [X] 15 g's

#2 Connected [X] 50 g's

#3 Connected [X] 15 g's

Mounting Pattern of Pendulum Mass (Viewed from Rear)

[2]

[1] [3]

J-Box Connectors tightened [X]

J-Box Cable connected to Control Box [X]

#1 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

100 gain # 8 channel into Tape Recorder

#2 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

300 gain # 9 channel into Tape Recorder

#3 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

100 gain #10 channel into Tape Recorder

4. SPEED TRANSDUCERS

Connected correctly to reference cell [X]

Connectors on reference cell correct [X]

#1 Slots lined up [X]

Distance between first two 2 ft.

Distance between second two 2 ft.

Distance between sets 5/7 ft.

#2 Connected correctly to control box [X]

Control box on [ ]

Cable from RCDR to channel -- on tape recorder

#3 Cable from #1 to INPUTA on freq. counter [--]

Frequency counter turned on [--]

Sensitivity on [--]

#1 recorded on channel --

#2 recorded on channel --

5. CAMERA

PPS Dial 70 Mult Switch 10

Speed Reducer H Servo Brake L

Drag Brake 30 F Setting 5.6 Film ASA B&W

Light meter reading 14 Film 400

Film correct [X] Prism correct [X] Trip switch [X]

Camera on stop [X] Timing light on [X] 100 pulses/sec

Balanced [X] Remote cable on [X] Power cable on [X]

Focus setting 25

View portal correct [X]

6. CRUSH CHARACTERISTICS

Honeycomb: #1 75 psi 1/4 6"22 Vertical Dimension

#2 130 psi 3/16 6"22

#3 230 psi 1/4 6"22

7. POLE Type: 33' Union Metal Steel Luminaire

Set up [X] Torqued exactly [X] Torque 150 ft-lbs.

8. TIMING LINES

Frequency 1K hz Voltage (peak to peak) 1 volts

Recorded on channel 1 input to tape recorder

9. TAPE RECORDER Tape # 001B

Speed 60 ips

Start of calibration 61

End of calibration 100] Meter Setting

Start of Test 101

Calibration signals recorded [X]

10. MASS

Weight 2250 lbs.

Correct height [X] Est. initial velocity 20 mph

Accelerometer cables out of danger [X]

11. LAST SECOND ITEMS

Arm control box [--]

Reset frequency counter [--]

Initial # of Pulses (vis)	3620
Initial # of Pulses (rec)	-
Final # of Pulses (rec)	4226
Impact meter reading	-
Final meter reading	137
Correction factor for height	.97
Amount of crush	≈ 6"

Remarks:

TEST # 005

DATA REDUCTION
FHWA/ENSCO IMPACT TEST FACILITY

1. Speed Transducers

A) Initial pulses 3620 → 27.62 fps = 18.8 mph .99 → 19.0 mph

B) Final pulses 4226 :Cor. Factor .96 → 24.65 fps = 16.81 mph

Weight of mass = 2275 lbs.

ΔMV = (weight /32.2) x (a-b) lb-sec.

= 208 lb-sec

2. Accelerometers

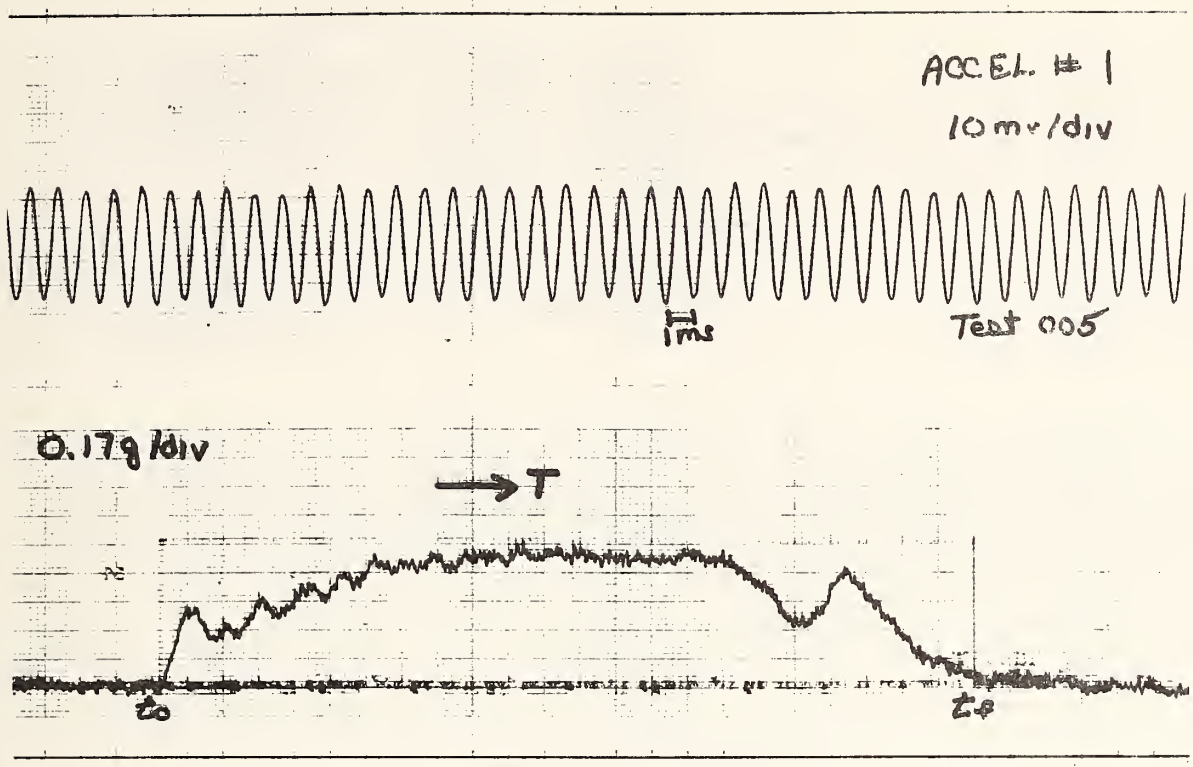
	Area	St. Area	Height of Ref.Curve	Height of Cal.Curve	Cal.g's	$\bar{g}$	Δt (ms)	Peak g's	Δ(MV)
	168	238							
#1	162	245	25	13	2.17	2.85	28.5	4.17	185
	165	242							
	144	248							
#2	144	254	26	37	7.2	2.90	28.5	3.9	188
	144	251		Ringing					
	182	300							
#3	181	310	27	13	2.13	2.63	32.5	4.4	194
	181	305							

$$\frac{1}{\Delta t}\int_0^{\Delta t} g\,dt = \frac{\text{Area}}{\text{St. Area}} * \text{Div.} * \frac{\text{Cal. g's}}{\text{Cal. Div.}}$$

$\overline{\Delta MV}$ = 194 lb-sec

$$M\Delta V = W\int_0^{\Delta t} g\,dt$$

DATE 6/25/75 jwa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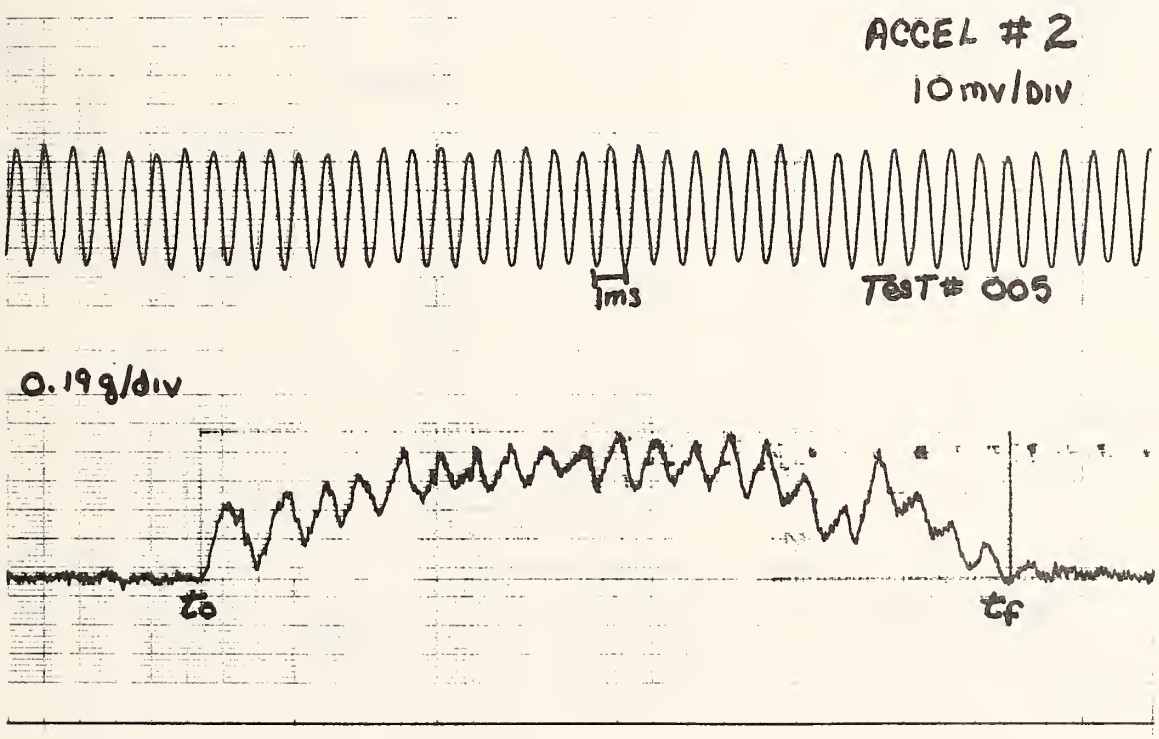
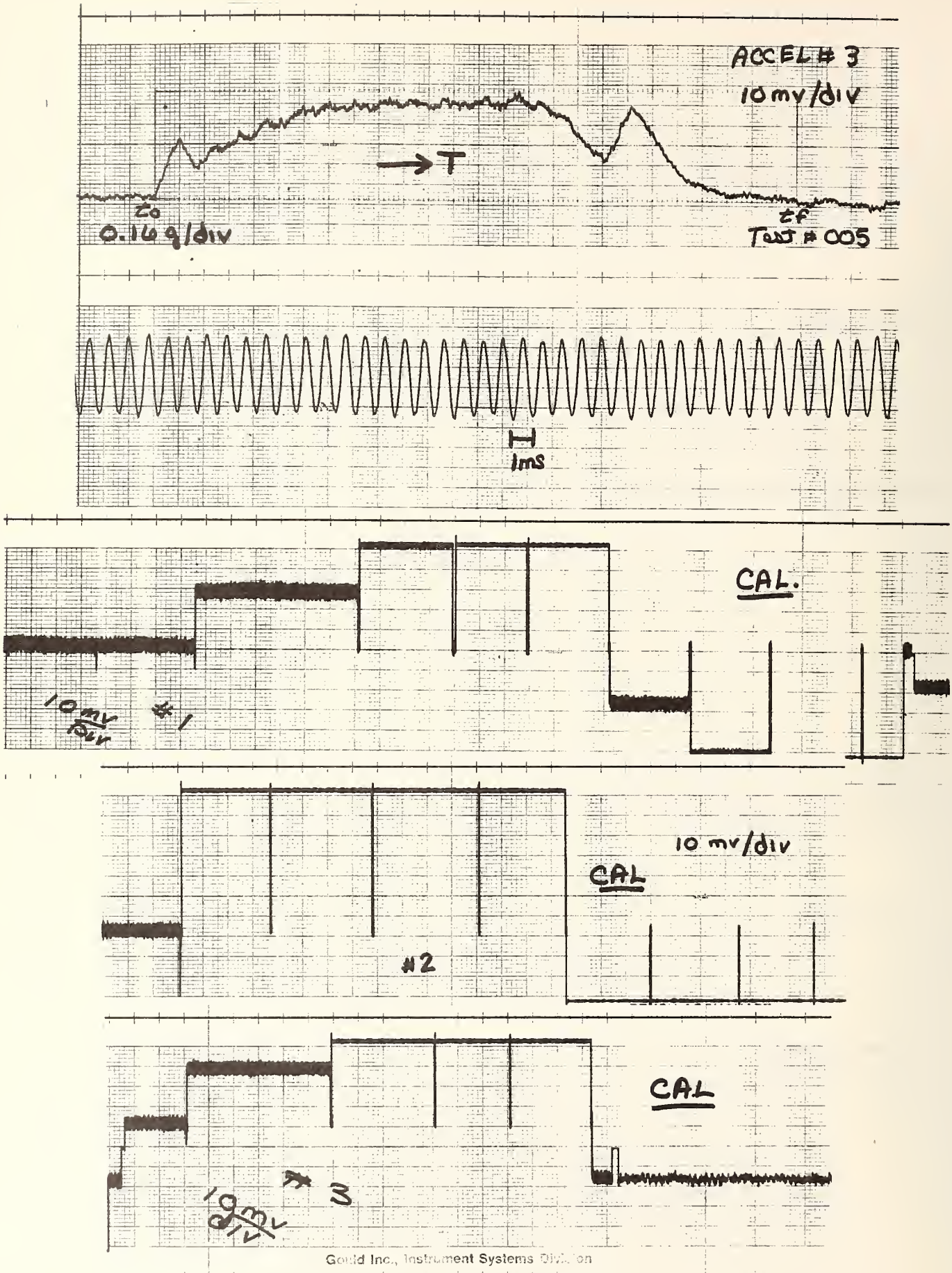
1ms
Test 005
0.17g/div
T
t_o
t_f


ACCEL # 2
10mv/DIV
1ms
TEST# 005
0.19g/div
t_o
t_f


ACCEL # 3
10 mv/div
→T
to
0.1 g/div
tf
Test # 005
H
1ms
CAL.
10 mv/div
#1
10 mv/div
CAL
#2
CAL
#3
10 mv/div

FHWA/ENSCO IMPACT TEST FACILITY
TEST REQUEST

Test No. 006

Pole/Support 33'6" Steel Slip Base Luminaire

Description of Setup: multi positional slip base
Torque to 150 ft-lbs

Camera: Required yes [X] no [ ]

Film Color [ ] B&W [X]

Min. Speed 400

Max. Speed 1000

Signals to be Recorded:

a. Accelerometers yes [X] no [ ]

b. Strain gauges yes [ ] no [X]

c. Speed transducers yes [X] no [ ]

d. Other _____

Crush Characteristics:

Honeycomb #1 75 psi (6"22) Vertical Dimension

#2 130 psi (6"22)

#3 230 psi (6"22)

Initial Speed: 20 mph

Mass (weight of pendulum mass): 2300 lbs.

Comments: This test is designed to show the effects of torquing the slip bolts to a level of 150 ft-lbs

FHWA/ENSCO IMPACT TEST FACILITY

Test No. 006 Date: 6/24/75 Weather: Hot

Personnel Present: JWA, RPO, LM, HT

1. POWER

Circuit breakers on

1	[X]	2	[X]	3	[X]
4	[X]	8	[X]	10	[X]
11	[X]	13	[X]	14	[X]

2. RELEASE HOOK

Attached [X] Plugged In [X] Switch On [X]

3. ACCELEROMETERS

Mounted Correctly [X]

#1 Connected [X] 15 g's

#2 Connected [X] 50 g's

#3 Connected [X] 15 g's

Mounting Pattern of Pendulum Mass (Viewed from Rear)

[2]

[1] [3]

J-Box Connectors tightened [X]

J-Box Cable connected to Control Box [X]

#1 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

100 gain # 8 channel into Tape Recorder

#2 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

300 gain # 9 channel into Tape Recorder

#3 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

100 gain # 10 channel into Tape Recorder

4. SPEED TRANSDUCERS

Connected correctly to reference cell [X]

Connectors on reference cell correct [X]

Slots lined up [X]

Distance between first two 2 ft.

Distance between second two 2 ft.

Distance between sets 5/7 ft. 2 (1st)

Connected correctly to control box [X]

Control box on [X]

Cable from RCDR to channel -- on tape recorder

Cable from #1 to INPUTA on freq. counter [--]

Frequency counter turned on [--]

Sensitivity on [--]

#1 recorded on channel --

#2 recorded on channel --

5. CAMERA

PPS Dial 70 Mult Switch 10

Speed Reducer H Servo Brake L

Drag Brake 30 F Setting F4.5 Film ASA 400

Light meter reading 13.5 Film B&W

Film correct [X] Prism correct [X] Trip switch [X]

Camera on stop [X] Timing light on [X] 100 pulses/sec

Balanced [X] Remote cable on [X] Power cable on [X]

Focus setting 25

View portal correct [X]

6. CRUSH CHARACTERISTICS

Honeycomb:	#1	75	1/4"	6"22 Vertical Dimension
	#2	130	3/16"	6"22
	#3	230	1/4"	6"22

7. POLE Type: 33'6" Union Steel Luminaire Slip Base

Set up [X] Torqued exactly [X] Torque 7/50 ft-lbs.

1/2 turn from hand tight

8. TIMING LINES

Frequency 1K hz Voltage (peak to peak) 1 volts

Recorded on channel 1 input to tape recorder

9. TAPE RECORDER Tape # 001B

Speed 60 ips

Start of calibration 161

End of calibration 199] Meter Setting

4. Start of Test 199

Calibration signals recorded [X]

10. MASS

Weight 2250 lbs.

Correct height [X] Est. initial velocity 20 mph

Accelerometer cables out of danger [X]

11. LAST SECOND ITEMS

Arm control box [--]

Reset frequency counter [--]

Initial # of Pulses (vis)	-
Initial # of Pulses (rec)	3517
Final # of Pulses (rec)	3915
Impact meter reading	-
Final meter reading	350
Correction factor for height	.96
Amount of crush	≈7"

Remarks:

TEST # 006

DATA REDUCTION
FHWA/ENSCO IMPACT TEST FACILITY

1. Speed Transducers

A) Initial pulses 3517 → 28.7 fps = 19.58 mph

B) Final pulses 3915 :Cor. Factor .97 → 26.3 fps = 17.95 mph

Weight of mass = 2300 lbs.

ΔMV = (weight /32.2) x (a-b) lb-sec

= 177(?) lb-sec

2. Accelerometers

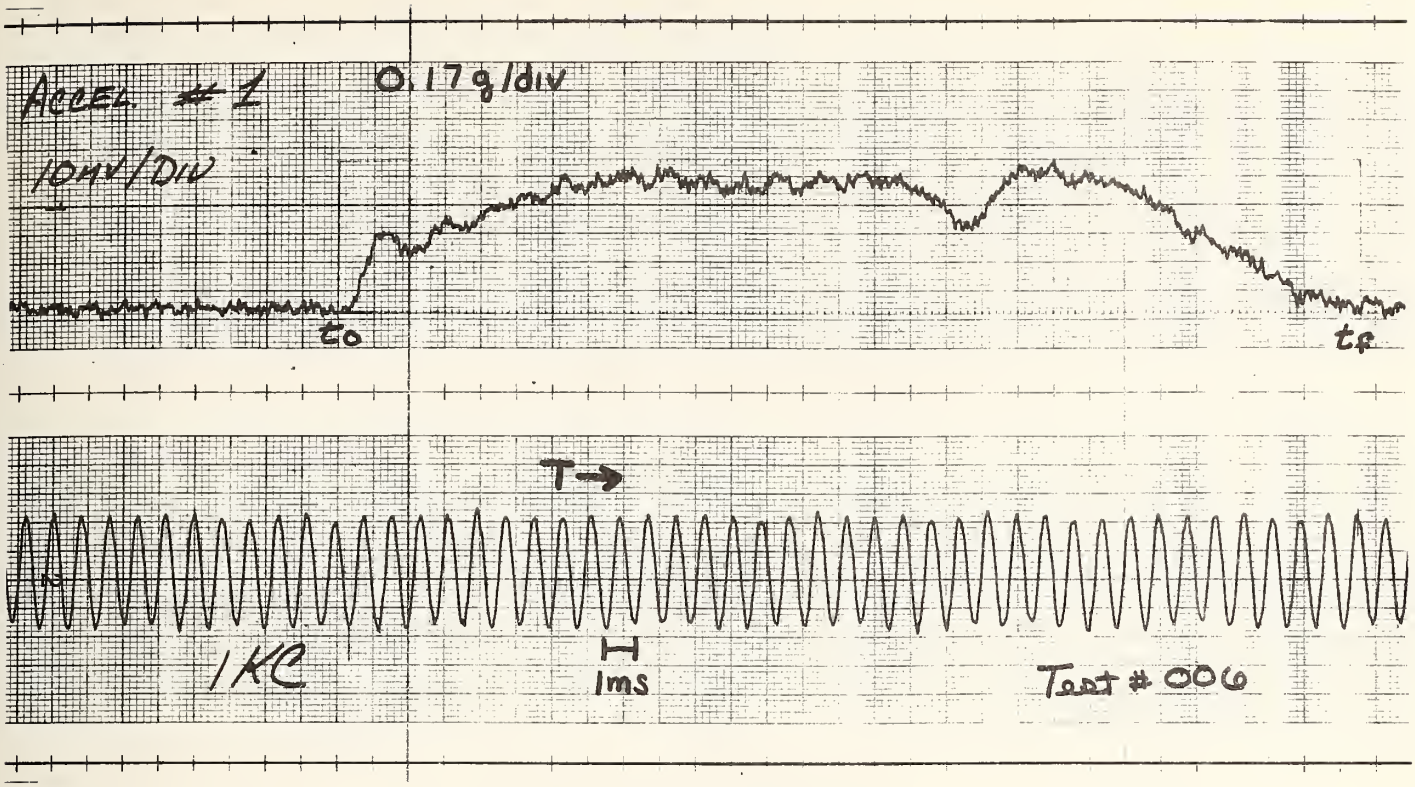
	Area	St. Area	Height of Ref.Curve	Height of Cal.Curve	Cal.g's	$\bar{g}$	Δt (ms)	Peak g's	Δ(MV)
	219	321							
#1	213	322	27	13	2.16	3.01	35.5	4.5	246
	216	322							
	191	392							
#2	190	396	33	39	7.2	2.94	35.5	4.6	240
	190	394							
	208	320							
#3	210	318	27	13	2.13	2.9	35.5	4.4	237
	209	319							

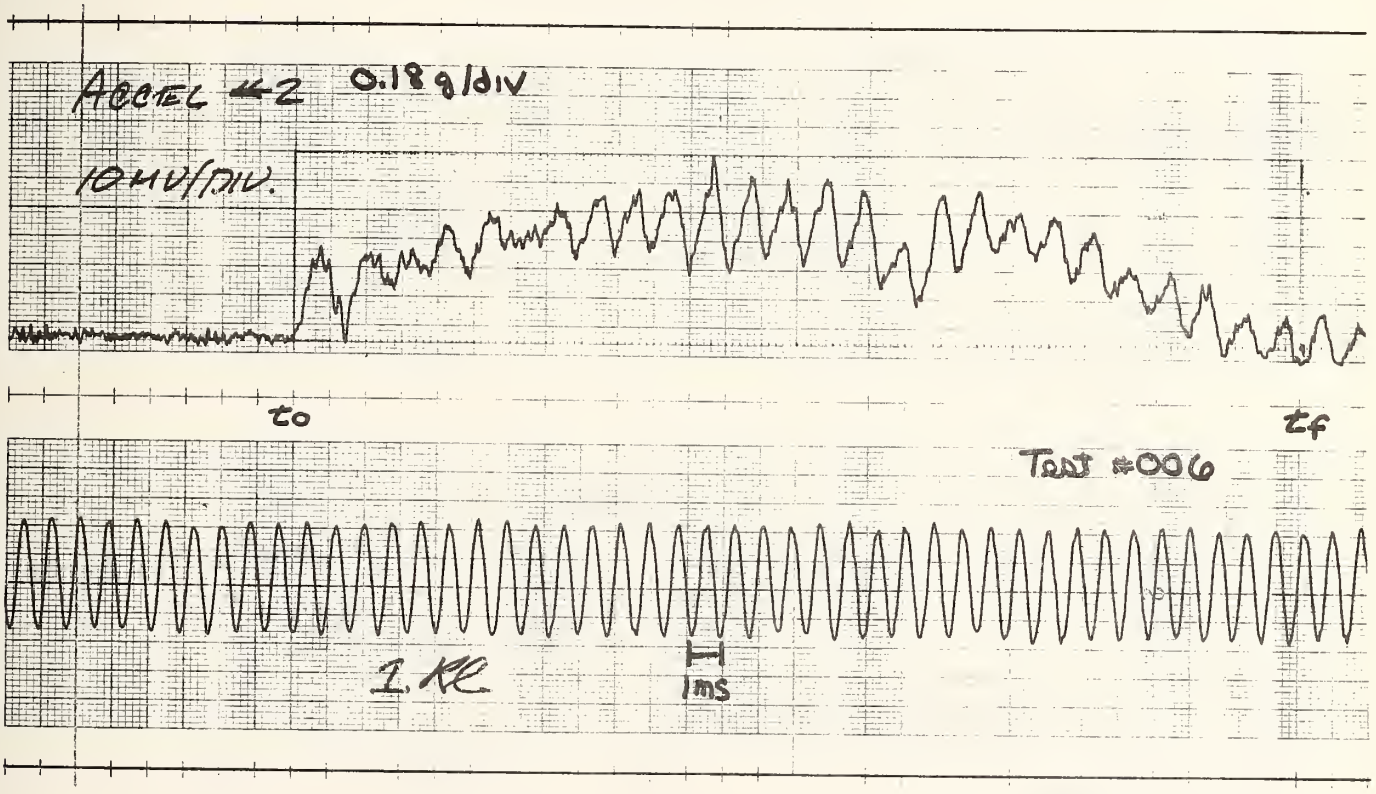
$$\frac{1}{\Delta t}\int_0^{\Delta t} g\,dt = \frac{\text{Area}}{\text{St. Area}} * \text{Div.} * \frac{\text{Cal. g's}}{\text{Cal. Div.}}$$

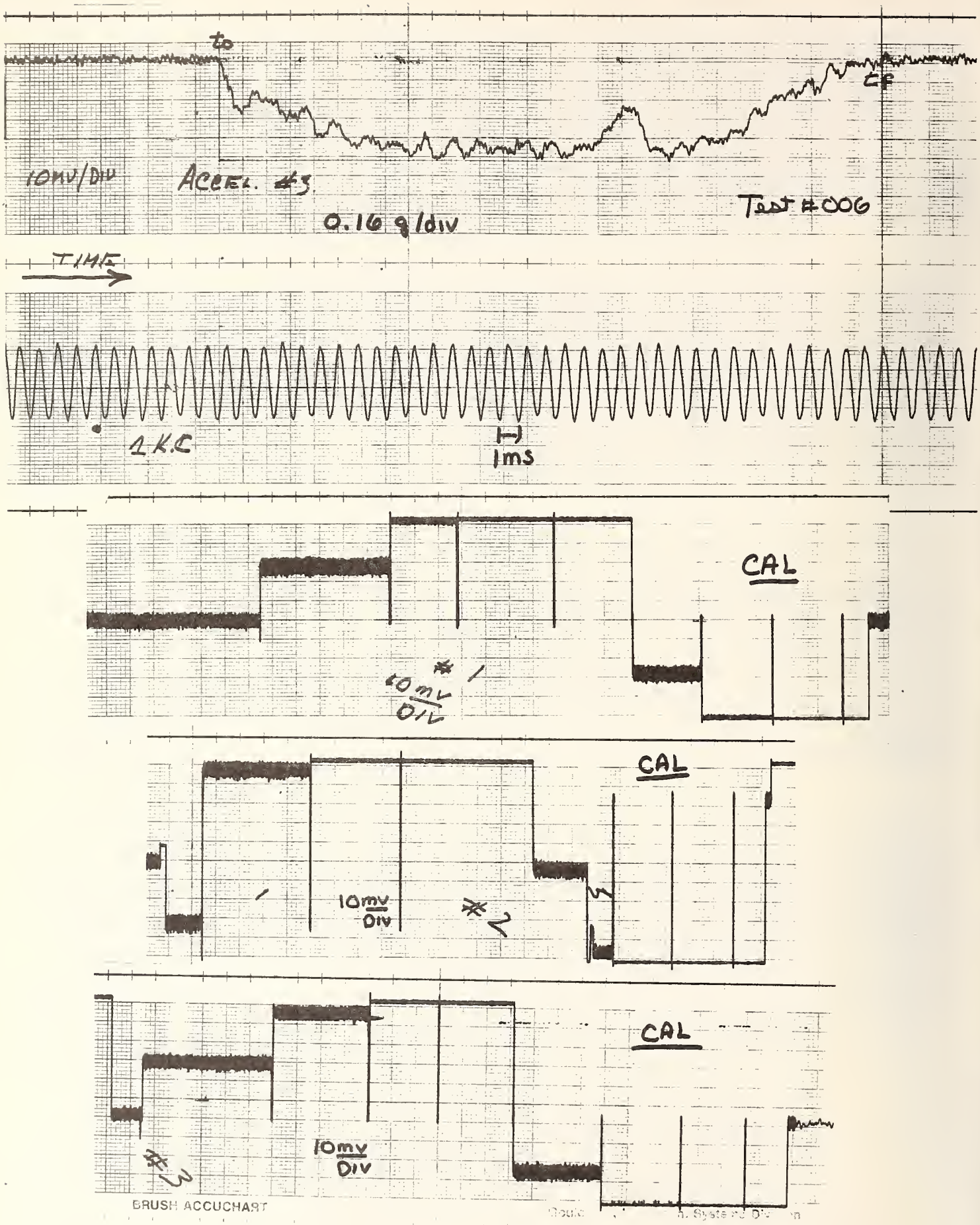
$\overline{\Delta MV}$ = 241

$$M\Delta V = W\int_0^{\Delta t} g\,dt$$

DATE 6/25/75 gwa


ACCEL #1
0.17 g/div
10MV/DIV
to
tf
T→
1KC
1ms
TEST #006


ACCEL #2
0.18 g/div
10MV/DIV.
to
tf
TEST #006
1 KC
1ms


to
tf
10MV/DIV
ACCEL. #3
0.16 g/div
TEST #006
TIME
1 K.C
1ms
CAL
#1
10 mv/DIV
#2
CAL
10mv/Div
#2
CAL
#3
10mv/Div
BRUSH ACCUCHART

FHWA/ENSCO IMPACT TEST FACILITY
TEST REQUEST

Test No. 007

Pole/Support 33 ft. Steel Luminaire (Union Metal)

Description of Setup:

Slip, Rigid Face Test

No Crush

No Base Force

Camera: Required yes [X] no [ ]

Film Color [ ] B&W [X]

Min. Speed 400

Max. Speed 800

Signals to be Recorded:

a. Accelerometers yes [X] no [ ]

b. Strain gauges yes [ ] no [X]

c. Speed transducers yes [X] no [ ]

d. Other

Crush Characteristics:

Honeycomb #1 None

#2 -

#3 -

Initial Speed: 20 mph

Mass (weight of pendulum mass): 2300 lbs.

Comments: This RIGID FACE TEST is designed to predict the momentum change due to the third phase. The crush is eliminated along with the force on the base.

FHWA/ENSCO IMPACT TEST FACILITY

Test No. 007 Date: 7/16/75 Weather: Threatening

Personnel Present: JWA,GR

1. POWER

Circuit breakers on

1	X	2	X	3	X
4	X	8	X	10	X
11	X	13	X	14	X

2. RELEASE HOOK

Attached [X] Plugged In [X] Switch On [X]

3. ACCELEROMETERS

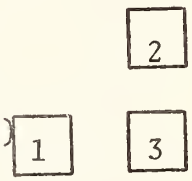
Mounted Correctly [X]

#1 Connected [X] 15 g's

#2 Connected [X] 50 g's

#3 Connected [X] 15 g's

Mounting Pattern of Pendulum Mass (Viewed from Rear)



J-Box Connectors tightened [X]

J-Box Cable connected to Control Box [X]

#1 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

100 gain # 8 channel into Tape Recorder

#2 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

300 gain # 9 channel into Tape Recorder

#3 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

100 gain # 10 channel into Tape Recorder

4. SPEED TRANSDUCERS

Connected correctly to reference cell [X]

Connectors on reference cell correct [X]

Slots lined up [X]

Distance between first two 2 ft.

Distance between second two 2 ft.

Distance between sets 4/6 ft.

Connected correctly to control box [X]

Control box on [X]

Cable from RCDR to channel - on tape recorder

Cable from #1 to INPUTA on freq. counter [X]

Frequency counter turned on [X]

Sensitivity on [X]

#1 recorded on channel _____

#2 recorded on channel _____

5. CAMERA

PPS Dial 60 Mult Switch 10

Speed Reducer H Servo Brake L

Drag Brake 30 F Setting 5.6 Film ASA 400

Light meter reading 14 Film B&W

Film correct [X] Prism correct [X] Trip switch [X]

Camera on stop [X] Timing light on [X] 100 pulses/sec

Balanced [X] Remote cable on [X] Power cable on [X]

Focus setting 23

View portal correct [ ]

6. CRUSH CHARACTERISTICS

Honeycomb: #1 _____

#2 RIGID FACE

#3 _____

7. POLE Type: 33 ft. Steel Luminaire

Set up [X] Torqued exactly [X] Torque 20 ft-lbs.

8. TIMING LINES

Frequency 1 khz Voltage (peak to peak) 1 volts

Recorded on channel 1 input to tape recorder

9. TAPE RECORDER Tape # 001B

Speed 60 ips

Start of calibration 300

End of calibration 341 Meter Setting

Start of Test 341

Calibration signals recorded [X]

10. MASS

Weight 2300 lbs.

Correct height [X] Est. initial velocity 20 mph

Accelerometer cables out of danger [X]

11. LAST SECOND ITEMS

Arm control box [-]

Reset frequency counter [-]

Initial # of Pulses (vis)	-
Initial # of Pulses (rec)	6680
Final # of Pulses (rec)	4216
Impact meter reading	362
Final meter reading	373
Correction factor for height	-
Amount of crush	None

Remarks:

TEST # 007

DATA REDUCTION
FHWA/ENSCO IMPACT TEST FACILITY

1. Speed Transducers

A) Initial pulses _____ → _____ fps = _____ mph

B) Final pulses _____ :Cor. Factor _____ → _____ fps = _____ mph

Weight of mass = _____ lbs.

ΔMV = (weight /32.2) x (a-b) lb-sec DATA UNUSABLE

= _____ lb-sec

2. Accelerometers

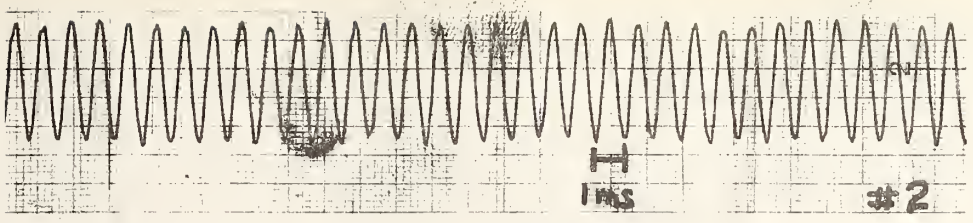
	Area	St. Area	Div.	Cal. Div.	Cal. g's	$\frac{1}{\Delta t}\int_0^{\Delta t} gdt$	Δt	$W\int_0^{\Delta t} gdt$
	82	120						
#1	82	120	28	20	6.5	6.22	12.5 ms	179
	82	129				Peak g's=9.1		
	70	100						
#2	66	100	23	20	7.2	5.63	12.5 ms	162
	68	100				Peak g's=8.3		
	82	120						
#3	88	122	28	20	6.41	6.30	12.5 ms	181
	85	121				Peak g's=9.0		

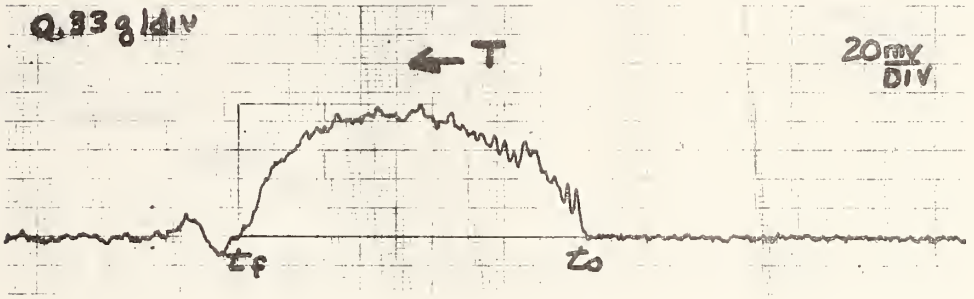
$$\frac{1}{\Delta t}\int_0^{\Delta t} gdt = \frac{\text{Area}}{\text{St. Area}} * \text{Div.} * \frac{\text{Cal. g's}}{\text{Cal. Div.}}$$

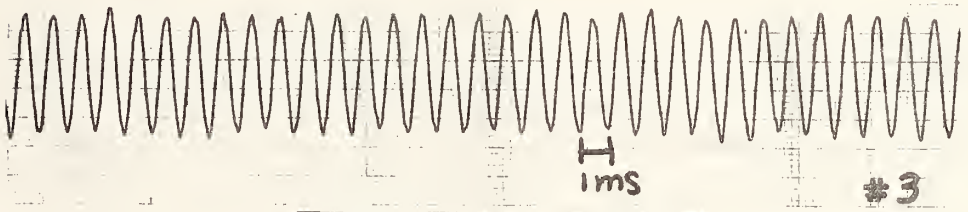
$M\Delta V$ 174 lb-sec

$$M\Delta V = W\int_0^{\Delta t} gdt$$

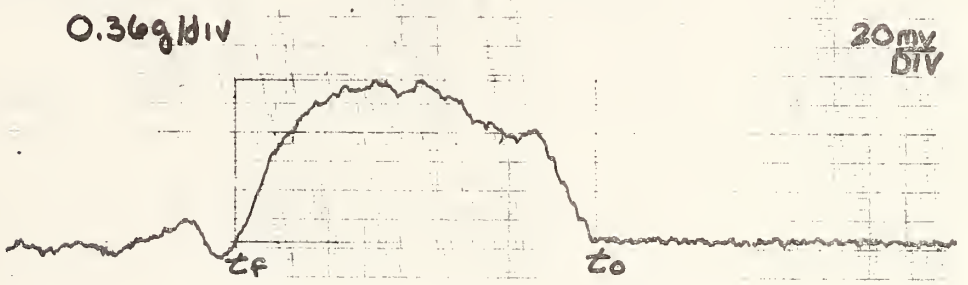
DATE 7/16/75 JWA

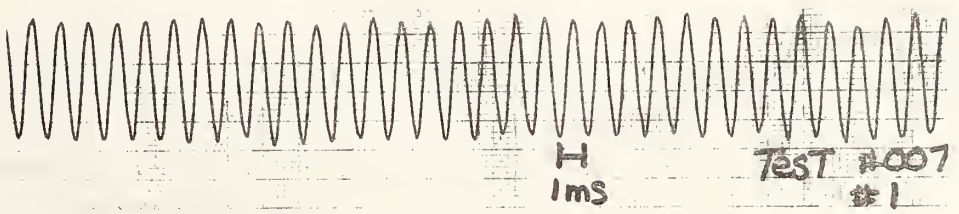

H
1ms
#2

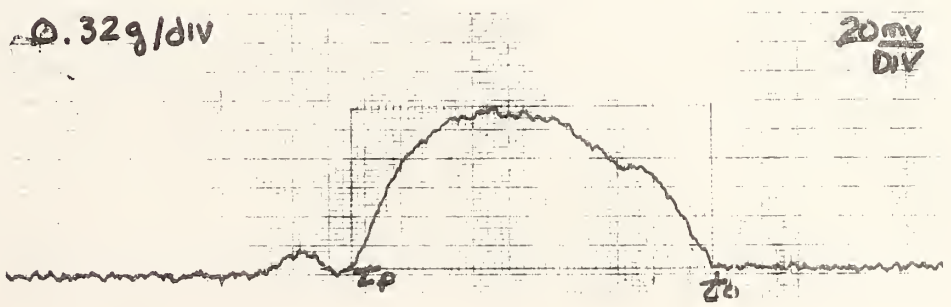

0.33g/div
T
20mv/DIV
t_f
t_o

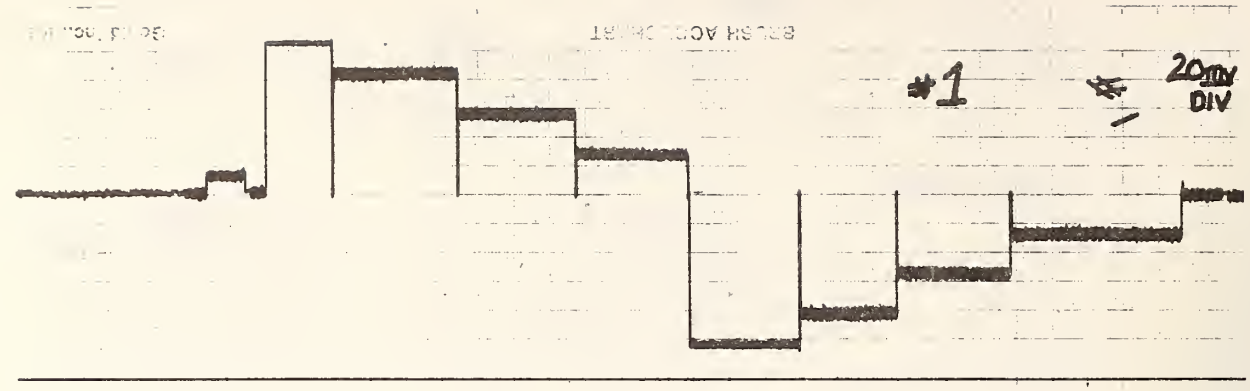

H
1ms
#3

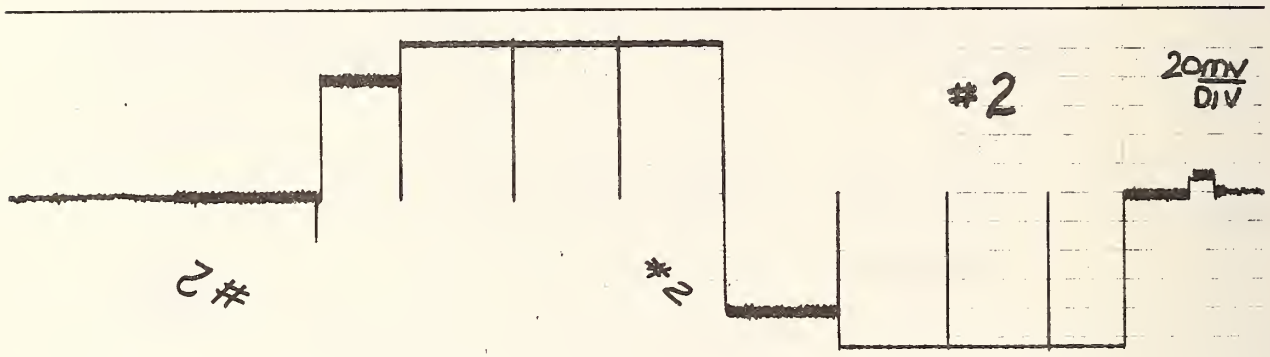
TEST 007


0.36g/div
20mv/DIV
t_f
t_o

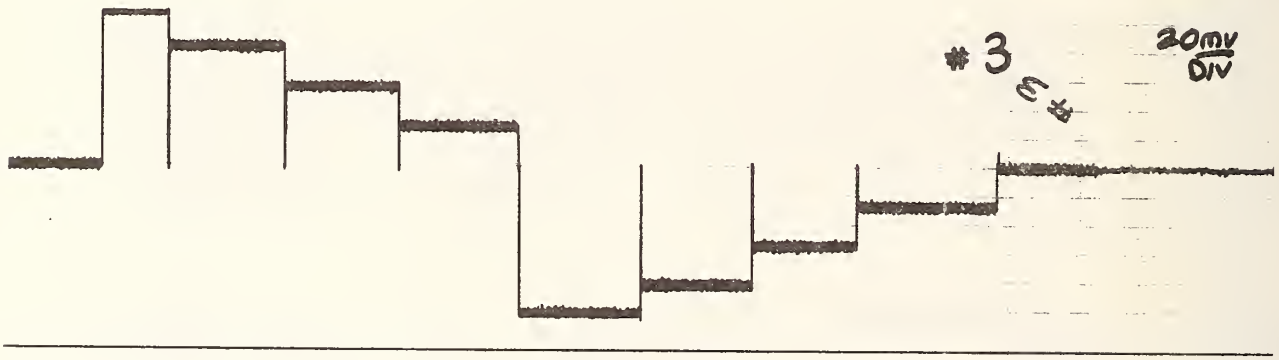

H
1ms
TEST #007
#1


0.32g/div
20mv/DIV
t_p
t_o





TEST 007



FHWA/ENSCO IMPACT TEST FACILITY
TEST REQUEST

Test No. 008

Pole/Support 40 foot Mounting height steel luminaire

Description of Setup: Slip Base Luminaire

Camera: Required yes [X] no [ ]

Film Color [ ] B&W [X]

Min. Speed 400

Max. Speed 800

Signals to be Recorded:

a. Accelerometers yes [X] no [ ]

b. Strain gauges yes [ ] no [X]

c. Speed transducers yes [X] no [ ]

d. Other _____

Crush Characteristics:

Honeycomb #1 75 psi 6".22 Vertical Dimension

#2 130 psi 6".22

#3 230 psi 6.22"

Initial Speed: 20 mph

Mass (weight of pendulum mass): 2250 lbs.

Comments: Test new acceptance standards use the turn of the nut method (half turn) from hand tight

FHWA/ENSCO IMPACT TEST FACILITY

Test No. 008 Date: 7/24/75 Weather: Good

Personnel Present: JWA, RPO, Tim Elder (Union Metal)

1. POWER

Circuit breakers on

1	[X]	2	[X]	3	[X]
4	[X]	8	[X]	10	[X]
11	[X]	13	[X]	14	[X]

2. RELEASE HOOK

Attached [X] Plugged In [X] Switch On [X]

3. ACCELEROMETERS

Mounted Correctly [X]

#1 Connected [X] 15 g's

#2 Connected [X] 50 g's

#3 Connected [X] 15 g's

Mounting Pattern of Pendulum Mass (Viewed from Rear)

[ ] [2]

[1] [3]

J-Box Connectors tightened [X]

J-Box Cable connected to Control Box [X]

#1 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

100 gain # 8 channel into Tape Recorder

#2 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

300 gain # 9 channel into Tape Recorder

#3 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

100 gain # 10 channel into Tape Recorder

4. SPEED TRANSDUCERS

Slots lined up [X]

Distance between first two 2 ft.

Distance between second two 2 ft.

Distance between sets 4/6 ft.

Connected correctly to control box [X]

Control box on [X] Reset [X]

Voltage Setting on Control Box:

1	2.5
2	2.5
3	2.5
4	2.5
R	2.5

5. CAMERA

PPS Dial 70 Mult Switch 10

Speed Reducer H Servo Brake L

Drag Brake 30 F Setting 5.6 Film ASA 400

Light meter reading 14 Film B&W

Film correct [X] Prism correct [X] Trip switch [X]

Camera on stop [X] Timing light on [X] 100 pulses/sec

Balanced [X] Remote cable on [X] Power cable on [X]

Focus setting 18 Lens Cap off [X]

View portal correct [X]

6. CRUSH CHARACTERISTICS

Honeycomb: #1 75 psi 6"22

#2 130 psi 6"22

#3 230 psi 6"22

7. POLE Type: 40' mounting ht Steel Luminaire

Set up [X] Torqued exactly [X] Torque - ft-lbs.

1/2 Turn After Medium Snug Tightening

8. TIMING LINES

Frequency 1000 hz Voltage (peak to peak) 1 volts

Recorded on channel 1 input to tape recorder

9. TAPE RECORDER Tape # 001B

Speed 60 ips

Start of calibration 407

End of calibration 475 Meter Setting

Start of Test 505

Calibration signals recorded [X]

10. MASS

Weight 2250 lbs.

Correct height [X] Est. initial velocity 20 mph

Accelerometer cables out of danger [X]

11. LAST SECOND ITEMS

Arm control box [X]

Initial # of Pulses (rec)	3515
Final # of Pulses (rec)	4587
Impact meter reading	540
Final meter reading	570
Amount of crush	23.25"-11=12.25"

Remarks:

TEST # 008

DATA REDUCTION
FHWA/ENSCO IMPACT TEST FACILITY

1. Speed Transducers

A) Initial pulses 3515 :Cor. Factor .99 → 28.7 fps = 19.6 mph

B) Final pulses 4587 :Cor. Factor .98 → 22.2 fps = 15.2 mph

Weight of mass = 2250 lbs.

ΔMV = (weight /32.2) x (a-b) lb-sec

= 451 lb-sec

2. Accelerometers

	Area	St. Area	Height of Ref.Curve	Height of Cal.Curve	Cal.g's	$\bar{g}$	Δt (ms)	Peak g's	Δ(MV)
	219	324							
#1	226	317	18	21	6.5	3.9	52	5.6	453
	223	321							
	188	284							
#2	191	281	16	20	7.2	3.9	51	5.8	445
	190	282							
	221	341							
#3	222	343	19	20	6.41	3.9	52	6.1	460
	222	342							

$$\frac{1}{\Delta t}\int_0^{\Delta t} g\,dt = \frac{\text{Area}}{\text{St. Area}} * \text{Div.} * \frac{\text{Cal. g's}}{\text{Cal. Div.}}$$

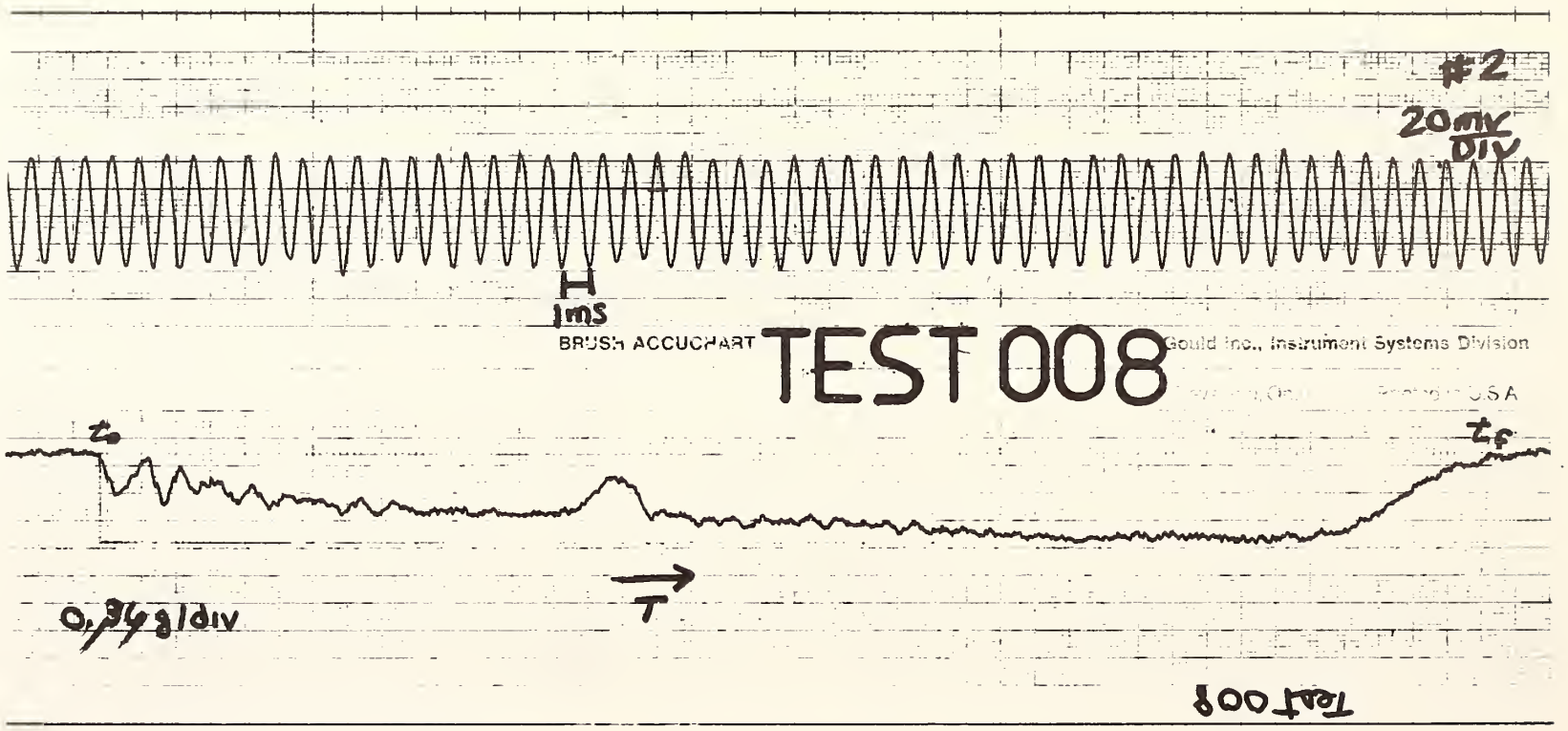
$\overline{M\Delta V}$ = 452 lb-sec

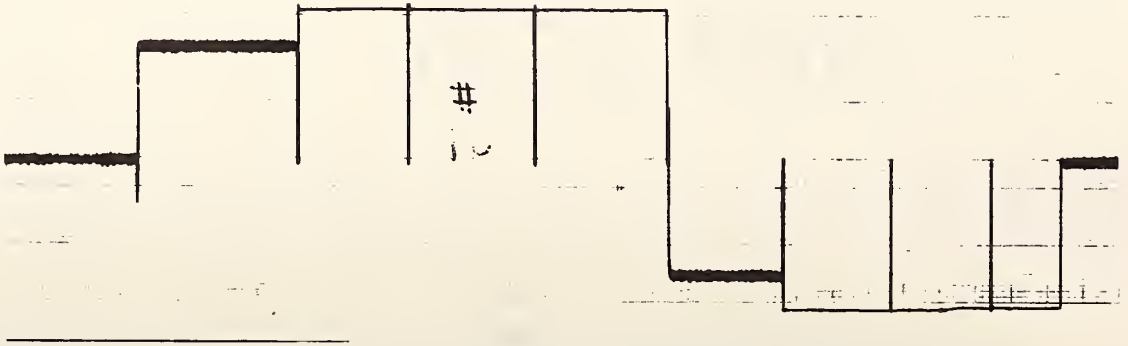
$$M\Delta V = W\int_0^{\Delta t} g\,dt$$

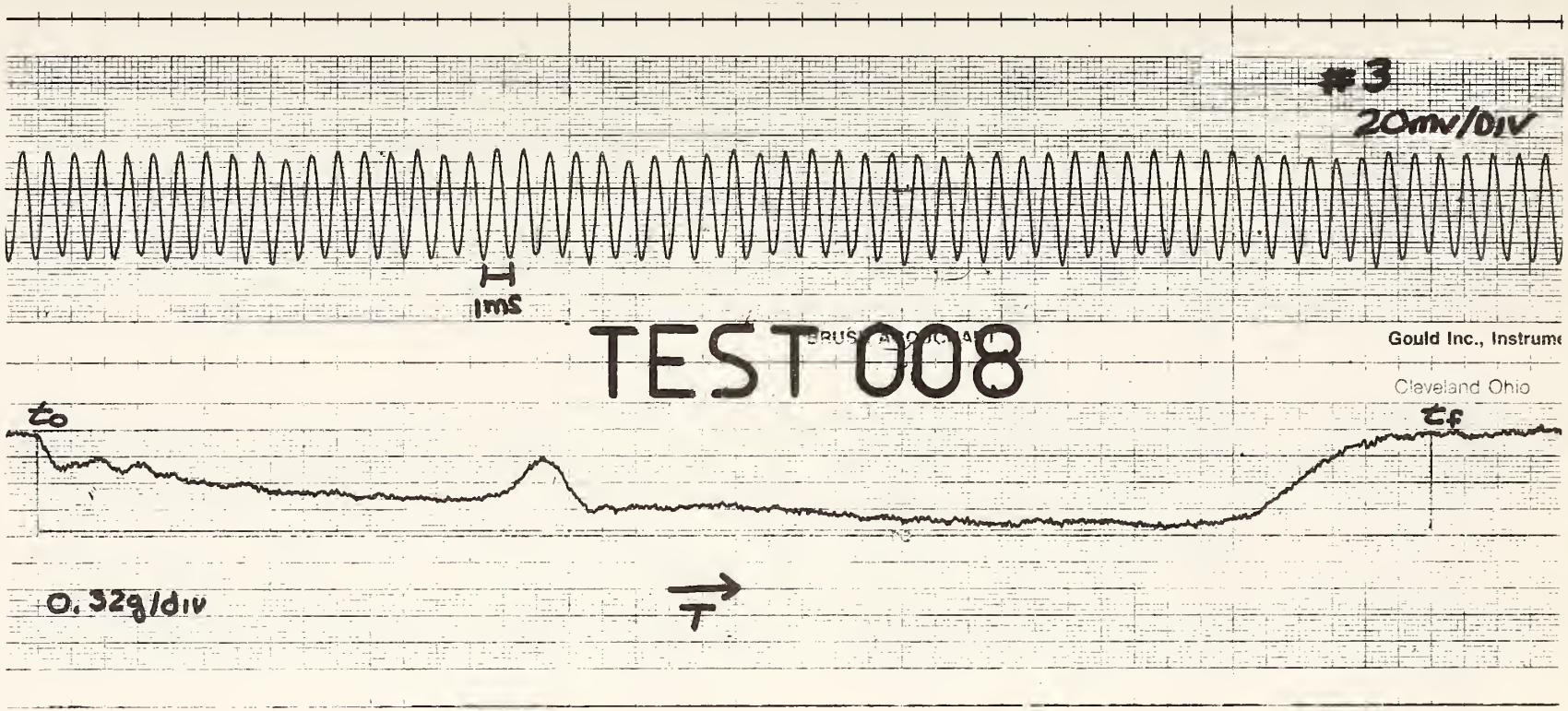
DATE 7/25/74 JWA

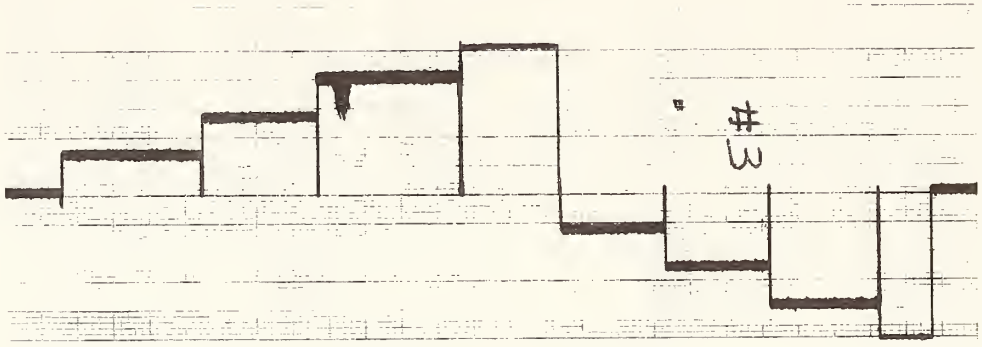
TEST 008
#1
20mV/DIV
1 ms
10
20
30
40
50
0.3 Volts/div

#1
20mV/DIV


#2
20mV DIV
1mS
BRUSH ACCUCHART
TEST 008
Gould Inc., Instrument Systems Division
U.S.A.
t0
t3
T




#3
20mv/DIV
1mS
TEST 008
Gould Inc., Instrume
Cleveland Ohio
to
tf
0.32g/div


#3

FHWA/ENSCO IMPACT TEST FACILITY
TEST REQUEST

Test No. 009

Pole/Support 40' Mounting Height Steel Luminaire

Description of Setup: Slip Base - Union Metal

Camera: Required yes [X] no [ ]

Film Color [ ] B&W [X]

Min. Speed 400

Max. Speed 800

Signals to be Recorded:

a. Accelerometers yes [X] no [ ]

b. Strain gauges yes [ ] no [X]

c. Speed transducers yes [X] no [ ]

d. Other _____

Crush Characteristics:

Honeycomb #1 75 psi 6"22 Vertical Dimension

#2 130 psi 6"22

#3 230 psi 6"22

Initial Speed: 20 mph

Mass (weight of pendulum mass): 2250 lbs.

Comments: Tighten bolts by turn of the nut method
1/2 turn after hand tight

FHWA/ENSCO IMPACT TEST FACILITY

Test No. 009 Date: 7/24/75 Weather: Good

Personnel Present: JWA, RPO, T. Elder (Union Metal)

1. POWER

Circuit breakers on

1	[X]	2	[X]	3	[X]
4	[X]	8	[X]	10	[X]
11	[X]	13	[X]	14	[X]

2. RELEASE HOOK

Attached [X] Plugged In [X] Switch On [X]

3. ACCELEROMETERS

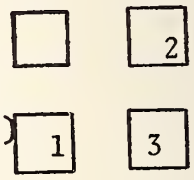
Mounted Correctly [X]

#1 Connected [X] 15 g's

#2 Connected [X] 50 g's

#3 Connected [X] 15 g's

Mounting Pattern of Pendulum Mass (Viewed from Rear)



J-Box Connectors tightened [X]

J-Box Cable connected to Control Box [X]

#1 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

100 gain # 8 channel into Tape Recorder

#2 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

300 gain # 9 channel into Tape Recorder

#3 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

100 gain # _____ channel into Tape Recorder

4. SPEED TRANSDUCERS

Slots lined up [X]

Distance between first two 2 ft.

Distance between second two 2 ft.

Distance between sets 4/6 ft.

Connected correctly to control box [X]

Control box on [X] Reset [X]

Voltage Setting on Control Box:

1	2.5
2	2.5
3	2.5
4	2.5
R	2.5

5. CAMERA

PPS Dial 70 Mult Switch 10

Speed Reducer H Servo Brake L

Drag Brake 30 F Setting 5.6 Film ASA 400

Light meter reading 14 Film B&W

Film correct [X] Prism correct [X] Trip switch [X]

Camera on stop [X] Timing light on [X] 100 pulses/sec

Balanced [X] Remote cable on [X] Power cable on [X]

Focus setting 28 Lens Cap off [X]

View portal correct [X]

6. CRUSH CHARACTERISTICS

Honeycomb: #1 75 psi 6"22 Vertical Dimension

#2 130 psi 6"22

#3 230 psi 6"22

7. POLE Type: 40' Mounting ht Steel Luminaire

Set up [X] Torqued exactly [-] Torque - ft-lbs.

"Snug" 1/2 Turn of the nut

8. TIMING LINES

Frequency 1000 hz Voltage (peak to peak) 1 volts

Recorded on channel 1 input to tape recorder

9. TAPE RECORDER Tape # 001B

Speed 60 ips

Start of calibration 580

End of calibration 622 Meter Setting

Start of Test 622

Calibration signals recorded [X]

10. MASS

Weight 2250 lbs.

Correct height [X] Est. initial velocity 20 mph

Accelerometer cables out of danger [X]

11. LAST SECOND ITEMS

Arm control box [X]

Initial # of Pulses (rec)	3474
Final # of Pulses (rec)	4312
Impact meter reading	680
Final meter reading	700
Amount of crush	23.25"-11=12.25"

Remarks: Secondary impact removed one eye bolt

TEST # 009

DATA REDUCTION
FHWA/ENSCO IMPACT TEST FACILITY

1. Speed Transducers

A) Initial pulses 3474 :Cor. Factor .99 → 28.8 fps = 19.6 mph

B) Final pulses 4312 :Cor. Factor .98 → 23.7 fps = 16.1 mph

Weight of mass = 2250 lbs.

ΔMV = (weight /32.2) x (a-b) lb-sec

= 358 lb-sec

2. Accelerometers

	Area	St. Area	Height of Ref.Curve	Height of Cal.Curve	Cal.g's	$\bar{g}$	Δt (ms)	Peak g's	Δ(MV)
	174	275							
#1	185	277	18	20	6.5	3.8	45	5.8	384
	179	276							
	154	248							
#2	158	252	17	20	7.2	3.8	44	6.1	378
	156	250							
	182	274							
#3	186	273	18	19	6.41	4.1	44	6.1	403
	184	274							

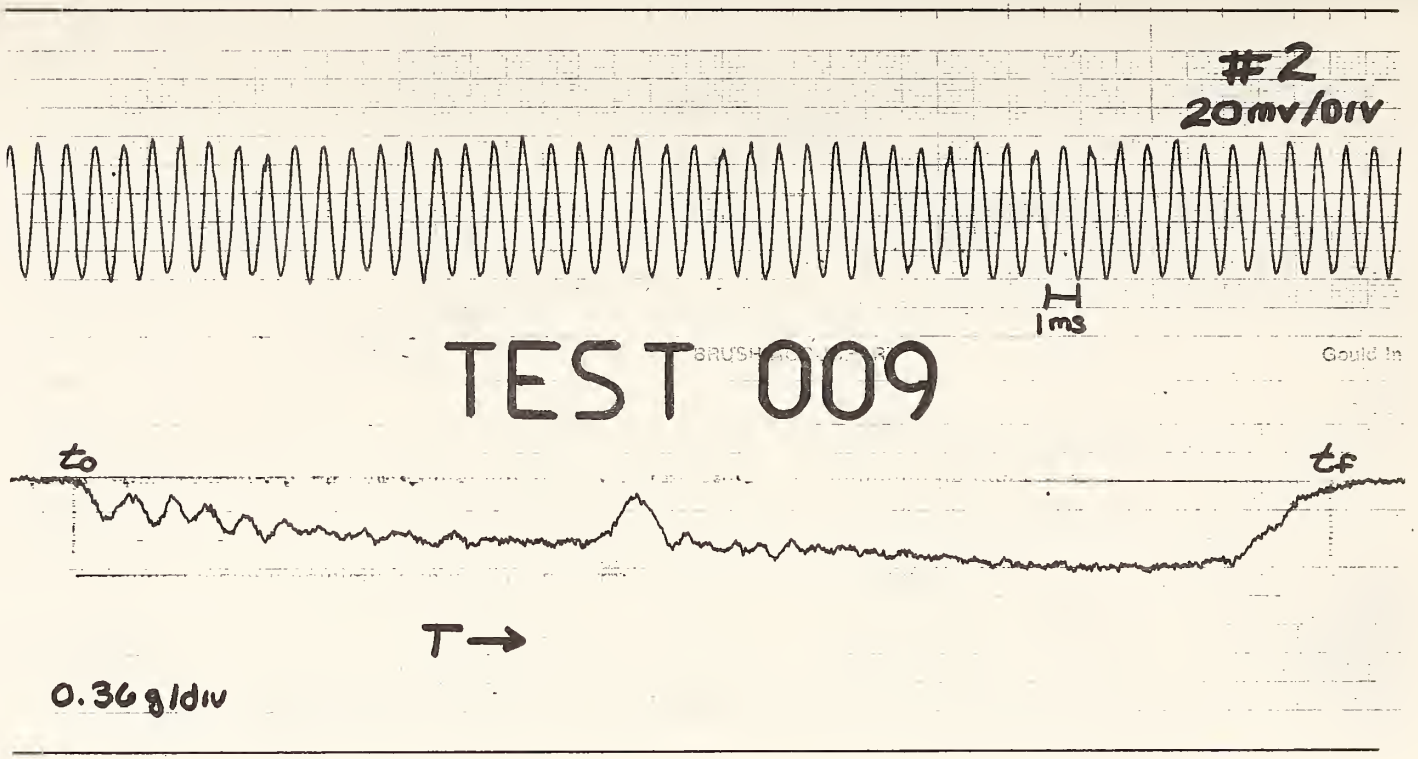
$$\frac{1}{\Delta t}\int_0^{\Delta t} gdt = \frac{\text{Area}}{\text{St. Area}} * \text{Div.} * \frac{\text{Cal. g's}}{\text{Cal. Div.}}$$

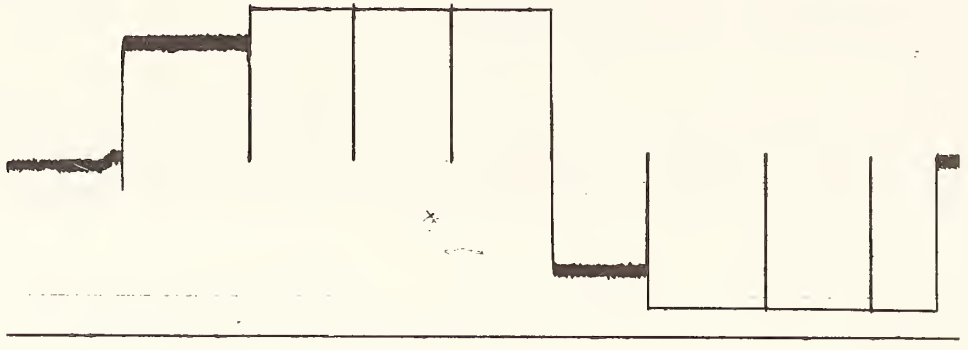
$\overline{M\Delta V}$ = 388 lb-sec

$$M\Delta V = W\int_0^{\Delta t} gdt$$

DATE 7/24/75 JWA

#1 20mv/DIV
1ms
TEST 009
zf
z0
T
0.33 g/DIV
#1


#2
20mv/div
1ms
TEST 009
Gould In
to
tf
T→
0.36g/div



TEST 009
1ms
#3
20 mV/DIV
0.348/DIV
T→

FHWA/ENSCO IMPACT TEST FACILITY
TEST REQUEST

Test No. 010

Pole/Support 40' Mounting Ht Steel Luminaire

Description of Setup: Slip base

Camera: Required yes [X] no [ ]

Film Color [ ] B&W [X]

Min. Speed 400

Max. Speed 800

Signals to be Recorded:

a. Accelerometers yes [X] no [ ]

b. Strain gauges yes [ ] no [X]

c. Speed transducers yes [X] no [ ]

d. Other _____

Crush Characteristics:

Honeycomb #1 75 psi 6"22

#2 130 psi 6"22

#3 230 psi 6"22

Initial Speed: 20 mph

Mass (weight of pendulum mass): 2250 lbs.

Comments: Attempt to Correlate TTI Test. Use Turn of the nut method

FHWA/ENSCO IMPACT TEST FACILITY

Test No. 010 Date: 7/24/75 Weather: Good

Personnel Present: JWA, RPO, T. Elder

1. POWER

Circuit breakers on

1	[X]	2	[X]	3	[X]
4	[X]	8	[X]	10	[X]
11	[X]	13	[X]	14	[X]

2. RELEASE HOOK

Attached [X] Plugged In [X] Switch On [X]

3. ACCELEROMETERS

Mounted Correctly [X]

#1 Connected [X] 15 g's

#2 Connected [X] 50 g's

#3 Connected [X] 15 g's

Mounting Pattern of Pendulum Mass (Viewed from Rear)

[ ] [2]

[1] [3]

J-Box Connectors tightened [X]

J-Box Cable connected to Control Box [X]

#1 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

100 gain # 8 channel into Tape Recorder

#2 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

300 gain # 9 channel into Tape Recorder

#3 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

100 gain # 10 channel into Tape Recorder

4. SPEED TRANSDUCERS

Slots lined up [X]

Distance between first two 2 ft.

Distance between second two 2 ft.

Distance between sets 4/6 ft.

Connected correctly to control box [X]

Control box on [X] Reset [X]

Voltage Setting on Control Box:

1	2.5
2	2.5
3	2.5
4	2.5
R	2.5

5. CAMERA

PPS Dial 60 Mult Switch 10

Speed Reducer H Servo Brake L

Drag Brake 30 F Setting 5.6 Film ASA 400

Light meter reading 13 Film B&W

Film correct [X] Prism correct [X] Trip switch [X]

Camera on stop [X] Timing light on [X] 100 pulses/sec

Balanced [X] Remote cable on [X] Power cable on [X]

Focus setting 28 Lens Cap off [X]

View portal correct [X]

6. CRUSH CHARACTERISTICS

Honeycomb: #1 75 psi 6"x22 Vertical Dimension

#2 130 psi 6"x22

#3 230 psi 6"x22

7. POLE Type: 40' Mounting height Steel Luminaire

Set up [X] Torqued exactly [-] Torque - ft-lbs.

Tight "snug", 1/2 Turn

8. TIMING LINES

Frequency 1000 hz Voltage (peak to peak) 1 volts

Recorded on channel 1 input to tape recorder

9. TAPE RECORDER Tape # 001B

Speed 60 ips

Start of calibration 655

End of calibration 701 Meter Setting

Start of Test 701

Calibration signals recorded [X]

10. MASS

Weight 2250 lbs.

Correct height [X] Est. initial velocity 20 mph

Accelerometer cables out of danger [X]

11. LAST SECOND ITEMS

Arm control box [X]

Initial # of Pulses (rec)	3472
Final # of Pulses (rec)	5364
Impact meter reading	732
Final meter reading	748
Amount of crush	23.25-8.75=14.5"

Remarks:

TEST # 010

DATA REDUCTION
FHWA/ENSCO IMPACT TEST FACILITY

1. Speed Transducers

A) Initial pulses 3472 :Cor. Factor .99 → 29.1 fps = 19.8 mph

B) Final pulses 5364 :Cor. Factor .97 → 19.0 fps = 13.0 mph

Weight of mass = 2250 lbs.

ΔMV = (weight /32.2) x (a-b) lb-sec

= 704 lb-sec

2. Accelerometers

	Area	St. Area	Height of Ref.Curve	Height of Cal.Curve	Cal.g's	$\bar{g}$	Δt (ms)	Peak g's	Δ(MV)
	293	572							
#1	293	566	28	26	8.64	4.7	57.5	9.3	620
	293	569							
	270	503							
#2	271	505	26	19	7.2	5.3	57.5	9.8	682
	270	504							
	288	517							
#3	285	510	27	20	6.41	4.8	57	8.6	618
	286	513							

$$\frac{1}{\Delta t}\int_0^{\Delta t} g\,dt = \frac{\text{Area}}{\text{St. Area}} * \text{Div.} * \frac{\text{Cal. g's}}{\text{Cal. Div.}}$$

$\overline{M\Delta V}$ = 656 lb-sec

$$M\Delta V = W\int_0^{\Delta t} g\,dt$$

DATE 7/24/75 JWA

T=0

1ms

#1 20mv/DIV

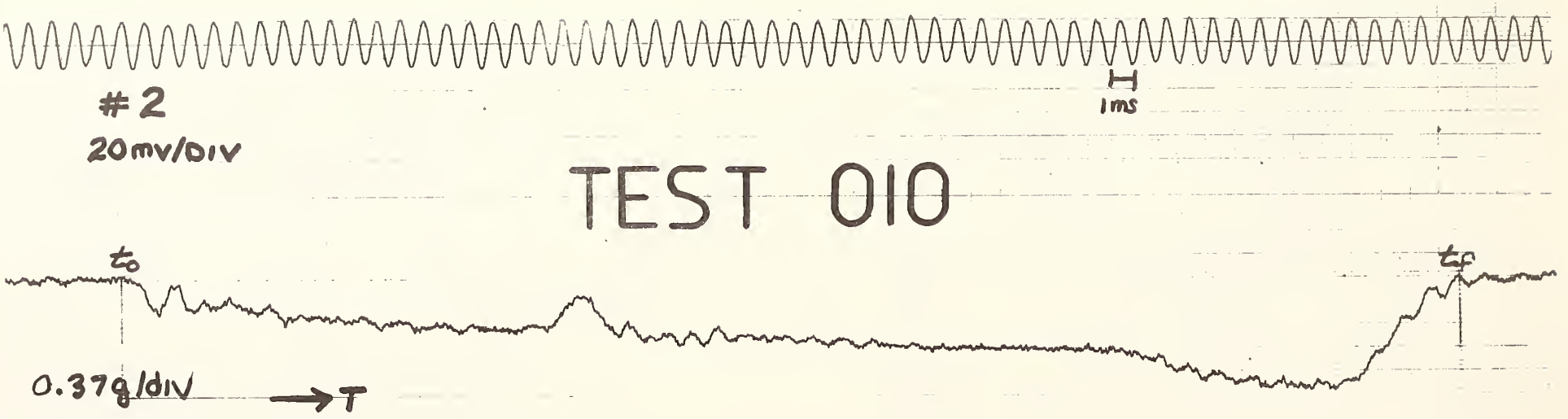
TEST 010

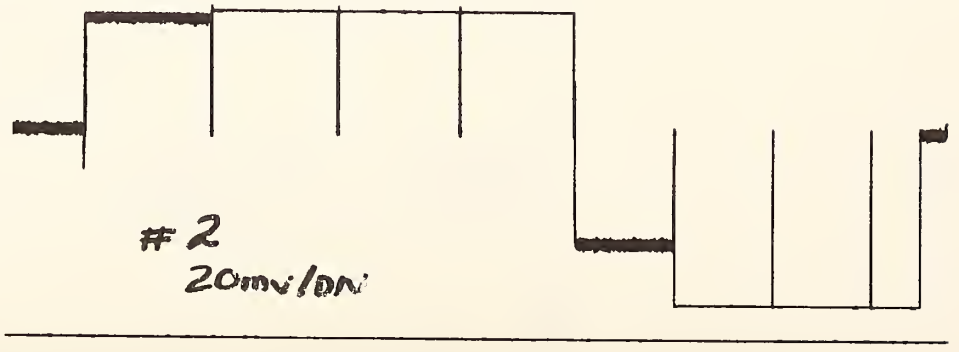
to

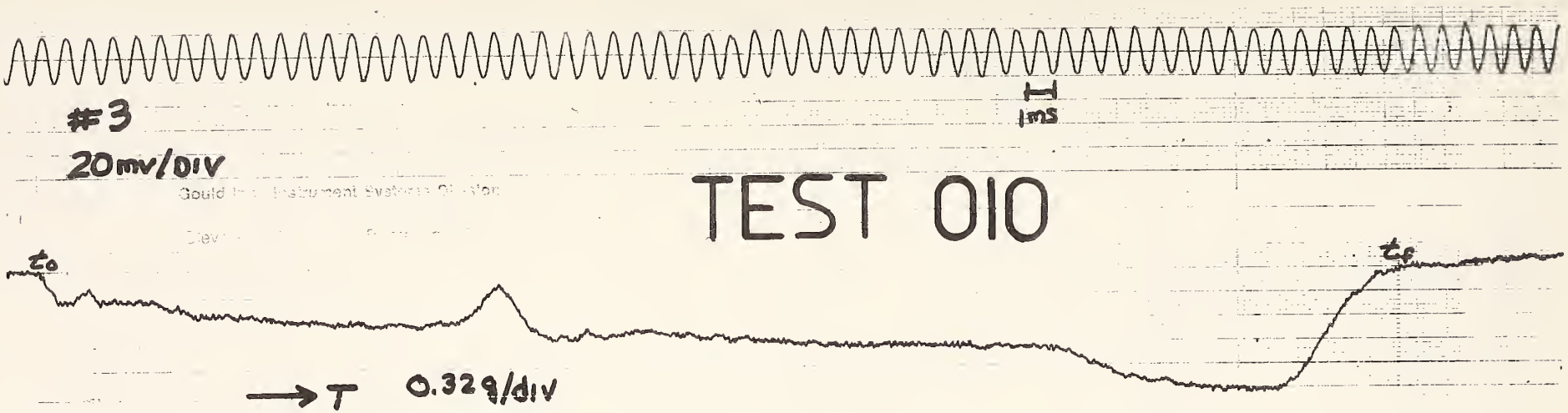
tf

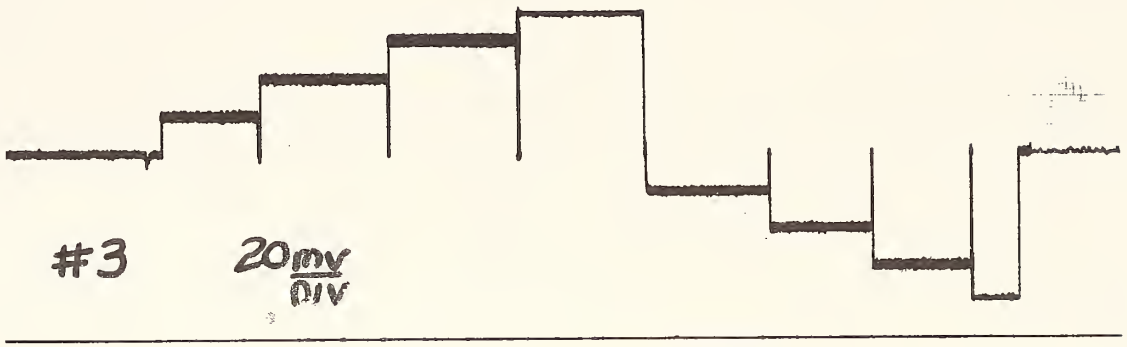
0.33 g/div → T

#1 20 mv/DIV


#2
20mv/DIV
1ms
TEST 010
t_0
t_p
0.37g/DIV
T


#2
20mv/DIV


#3
20mv/DIV
1ms
TEST 010
t_0
t_f
T
0.32g/div


#3
20 mv/DIV

APPENDIX B

TEST DATA FOR ALUMINUM LUMINAIRES WITH SHOE BASES

FHWA/ENSCO IMPACT TEST FACILITY
TEST REQUEST

Test No. 101

Pole/Support Aluminum shoe base 30' LUMINAIRE

Description of Setup: 6' by 24" Dia Foundation

Camera: Required yes [X] no [ ]

Film Color [X] B&W [ ]

Min. Speed 400

Max. Speed _____

Signals to be Recorded:

a. Accelerometers yes [X] no [ ]

b. Strain gauges yes [ ] no [X]

c. Speed transducers yes [X] no [ ]

d. Other time base 1000 HZ

Crush Characteristics:

Honeycomb #1 AL 3/16" - 5052 - .001n - 130 psi 8"

#2 AL 1/4" - 5052 - .002n - 230 psi 8"

#3 AL 1/8" - 5056 - .001n - 320 psi 8"

Initial Speed: 20 MPH

Mass (weight of pendulum mass): 2250 lbs.

Comments: Should produce a large change in speed of pendulum

FHWA/ENSCO IMPACT TEST FACILITY

Test No. 101 Date: 10/21/74 Weather: Clear

Personnel Present: JA, RO

1. POWER

Circuit breakers on

1	[X]	2	[X]	3	[X]
4	[X]	8	[X]	10	[X]
11	[X]	13	[X]	14	[X]

2. RELEASE HOOK

Attached [X] Plugged In [X] Switch On [X]

3. ACCELEROMETERS

Mounted Correctly [X]

#1 Connected [X] 15 g's

#2 Connected [X] 50 g's

#3 Connected [X] 15 g's

Mounting Pattern of Pendulum Mass (Viewed from Rear)

[2]

[1] [3]

J-Box Connectors tightened [X]

J-Box Cable connected to Control Box [X]

#1 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

100 gain # 8 channel into Tape Recorder

#2 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

300 gain # 9 channel into Tape Recorder

#3 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

100 gain # 10 channel into Tape Recorder

4. SPEED TRANSDUCERS

Connected correctly to reference cell [X]

Connectors on reference cell correct [X]

Slots lined up [X]

Distance between first two 2 ft.

Distance between second two 2 ft.

Distance between sets - ft.

Connected correctly to control box [X]

Control box on [X]

Cable from RCDR to channel - on tape recorder

Cable from #2 to INPUTA on freq. counter [X]

Frequency counter turned on [X]

Sensitivity on [X]

#1 recorded on channel 2

#2 recorded on channel 3

5. CAMERA

PPS Dial 80.0 Mult Switch x10

Speed Reducer H Servo Brake L

Drag Brake 30 F Setting 4 Film ASA 80

Light meter reading 15.5 Film Color

Film correct [X] Prism correct [X] Trip switch [X]

Camera on stop [X] Timing light on [X] 100 pulses/sec

Balanced [X] Remote cable on [X] Power cable on [X]

Focus setting 17

View portal correct [X]

6. CRUSH CHARACTERISTICS

Honeycomb: #1 AL 3/16" - 5052 - .001n - 130 psi

#2 AL 1/4" - 5052 - .002n - 230 psi

#3 AL 1/8" - 5056 - .001n - 320 psi

7. POLE Type: Aluminum shoe base

Set up [X] Torqued exactly [N/A] Torque N/A ft-lbs.

8. TIMING LINES

Frequency 1000 hz Voltage (peak to peak) 10 volts

Recorded on channel #1 input to tape recorder

9. TAPE RECORDER Tape # 001

Speed 60 ips

Start of calibration 250

End of calibration 297 Meter Setting

Start of Test 297

Calibration signals recorded [X]

10. MASS

Weight 2250 lbs.

Correct height [X] Est. initial velocity 20 mph

Accelerometer cables out of danger [X]

11. LAST SECOND ITEMS

Arm control box [X]

Reset frequency counter [X]

Initial # of Pulses (vis)	-
Initial # of Pulses (rec)	-
Final # of Pulses (rec)	2064
Impact meter reading	304
Final meter reading	327
Correction factor for height	.982
Amount of crush	7 15/16"

Remarks:

TEST # 101

DATA REDUCTION
FHWA/ENSCO IMPACT TEST FACILITY

1. Speed Transducers

A) Initial pulses - → 29.34 fps = 20 mph

B) Final pulses 2064 :Cor. Factor 98.2% → 15.42 fps = 10.51 mph

Weight of mass = 2250 lbs.

ΔMV = (weight /32.2) x (a-b) lb-sec

= 972 lb-sec

2. Accelerometers

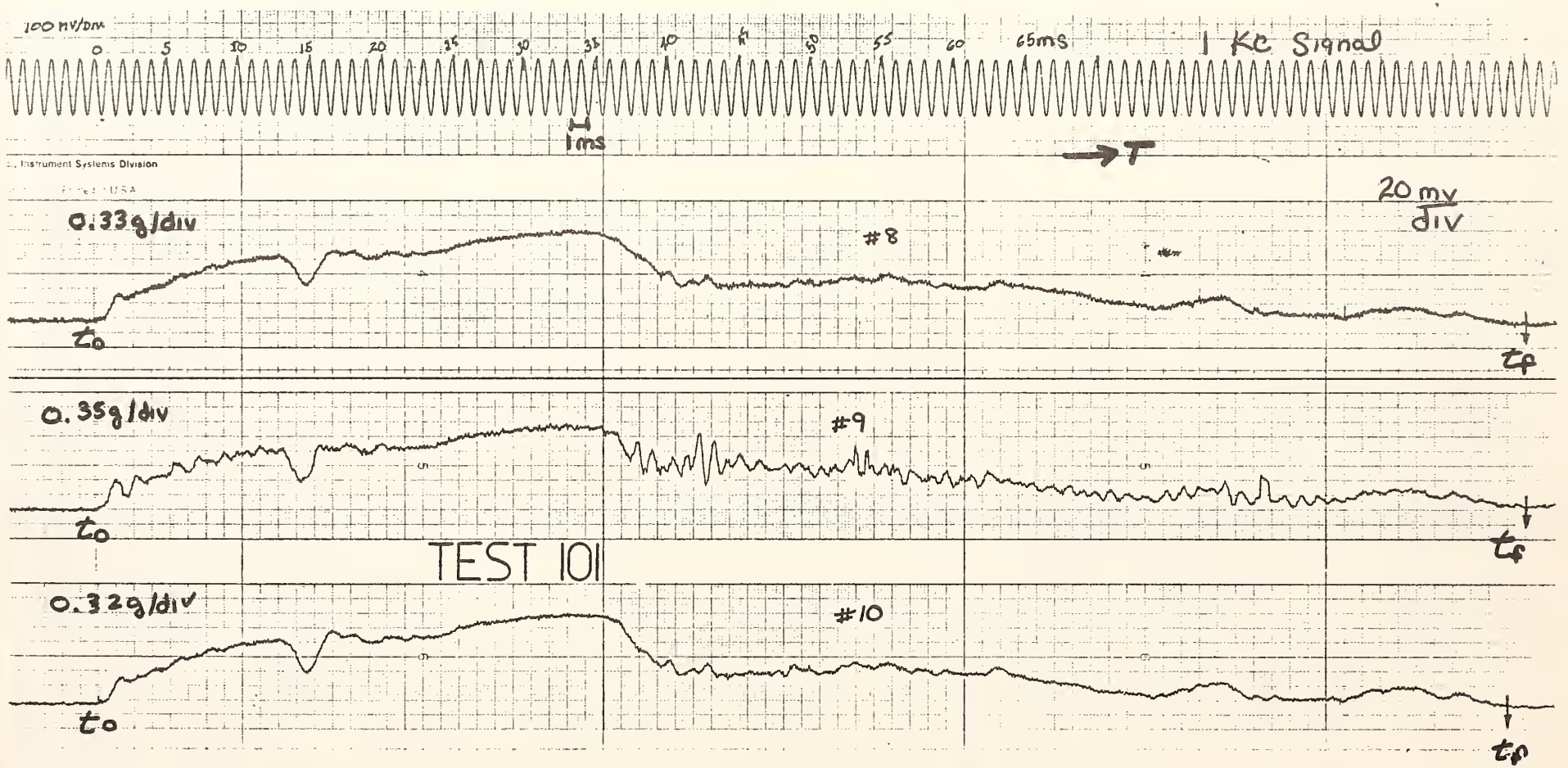
	Area	St. Area	Div.	Cal. Div.	Cal. g's	$\frac{1}{\Delta t}\int_0^{\Delta t} gdt$	Δt	$W\int_0^{\Delta t} gdt$
	5.97	19.65						
#1	6.00	19.59	40	20	6.50	3.96	100	891
	5.985	19.62						
	6.19	19.68						
#2	6.42	19.62	40	20.5	7.2	4.5	100	1014
	6.46	19.65						
	6.00	19.73						
#3	5.95	19.62	40	20	6.41	3.89	100	876
	5.975	19.67						

$$\frac{1}{\Delta t}\int_0^{\Delta t} gdt = \frac{\text{Area}}{\text{St. Area}} * \text{Div.} * \frac{\text{Cal. g's}}{\text{Cal. Div.}}$$

$M\Delta V$ = 943 lb-sec

$$M\Delta V = W\int_0^{\Delta t} gdt$$

DATE 10/22/74 JWA


100 mV/DIV
0
5
10
15
20
25
30
35
40
45
50
55
60
65ms
1 KC Signal
1ms
Instrument Systems Division
0.33g/div
#8
20 mv/div
t_0
t_f
0.35g/div
#9
t_0
t_f
TEST 101
0.32g/div
#10
t_0
t_f

#6
20mv/div
#9
TEST 101

FHWA/ENSCO IMPACT TEST FACILITY
TEST REQUEST

Test No. 102

Pole/Support 30' alum. shoe base

Description of Setup:

Tapered honeycomb to simulate TTI results

Camera: Required yes [✓] no [ ]

Film Color [ ] B&W [✓]

Min. Speed

Max. Speed 800

Signals to be Recorded:

a. Accelerometers yes [✓] no [ ]

b. Strain gauges yes [ ] no [✓]

c. Speed transducers yes [ ] no [✓]

d. Other

Crush Characteristics:

Honeycomb #1 130 psi 3."2

#2 230 psi 4."5

#3 320 psi 8"

Initial Speed: 20 mph

Mass (weight of pendulum mass): 2250 lbs.

Comments:

FHWA/ENSCO IMPACT TEST FACILITY

Test No. 102 Date: 4/12/75 Weather: Good

Personnel Present: JWA, RPO

1. POWER

Circuit breakers on

1	✓	2	✓	3	✓
4	✓	8	✓	10	✓
11	✓	13	✓	14	✓

2. RELEASE HOOK

Attached ✓ Plugged In ✓ Switch On ✓

3. ACCELEROMETERS

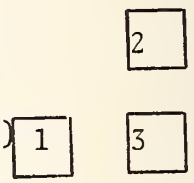
Mounted Correctly ✓

#1 Connected ✓ 15 g's

#2 Connected ✓ 50 g's

3 Connected ✓ 15 g's

Mounting Pattern of Pendulum Mass (Viewed from Rear)



J-Box Connectors tightened ✓

J-Box Cable connected to Control Box ✓

#1 10 volts Balanced [✓] Excitation [✓] Amp. Bal. [✓]

100 gain # 8 channel into Tape Recorder

#2 10 volts Balanced [✓] Excitation [✓] Amp. Bal. [✓]

300 gain # 9 channel into Tape Recorder

#3 10 volts Balanced [✓] Excitation [✓] Amp. Bal. [✓]

100 gain # 10 channel into Tape Recorder

4. SPEED TRANSDUCERS N/A

Connected correctly to reference cell [ ]

Connectors on reference cell correct [ ]

Slots lined up [ ]

Distance between first two _____ ft.

Distance between second two _____ ft.

Distance between sets _____ ft.

Connected correctly to control box [ ]

Control box on [ ]

Cable from RCDR to channel _____ on tape recorder

Cable from #1 to INPUTA on freq. counter [ ]

Frequency counter turned on [ ]

Sensitivity on [ ]

#1 recorded on channel _____

#2 recorded on channel _____

5. CAMERA

PPS Dial 80 Mult Switch 10

Speed Reducer H Servo Brake L

Drag Brake 30 F Setting 8 Film ASA 400

Light meter reading 15.5 Film 400 B&W

Film correct [✓] Prism correct [✓] Trip switch [✓]

Camera on stop [✓] Timing light on [✓] 100 pulses/sec

Balanced [✓] Remote cable on [✓] Power cable on [✓]

Focus setting 50

View portal correct [X]

6. CRUSH CHARACTERISTICS

Honeycomb: #1 130 psi 3."2 Tapered

#2 230 psi 4."5 Tapered

#3 320 psi 8."0

7. POLE Type: 30' alum. lum shoe base

Set up [✓] Torqued exactly [–] Torque _ ft-lbs.

8. TIMING LINES

Frequency 1 K hz Voltage (peak to peak) 10 volts

Recorded on channel 1 input to tape recorder

9. TAPE RECORDER Tape # 001A

Speed 60 ips

Start of calibration 740

End of calibration 783 Meter Setting

Start of Test 783

Calibration signals recorded [✓]

10. MASS

Weight 2250 lbs.

Correct height [✓] Est. initial velocity 20 mph

Accelerometer cables out of danger [✓]

11. LAST SECOND ITEMS

Arm control box [_]

Reset frequency counter [_]

Initial # of Pulses (vis)	_
Initial # of Pulses (rec)	_
Final # of Pulses (rec)	_
Impact meter reading	_
Final meter reading	803
Correction factor for height	_
Amount of crush	

Remarks:

TEST # 102

DATA REDUCTION
FHWA/ENSCO IMPACT TEST FACILITY

1. Speed Transducers

A) Initial pulses — → — fps = — mph

B) Final pulses —:Cor. Factor — → — fps = — mph

Weight of mass = 2250 lbs.

ΔMV = (weight /32.2) x (a-b) lb-sec

= — lb-sec

2. Accelerometers

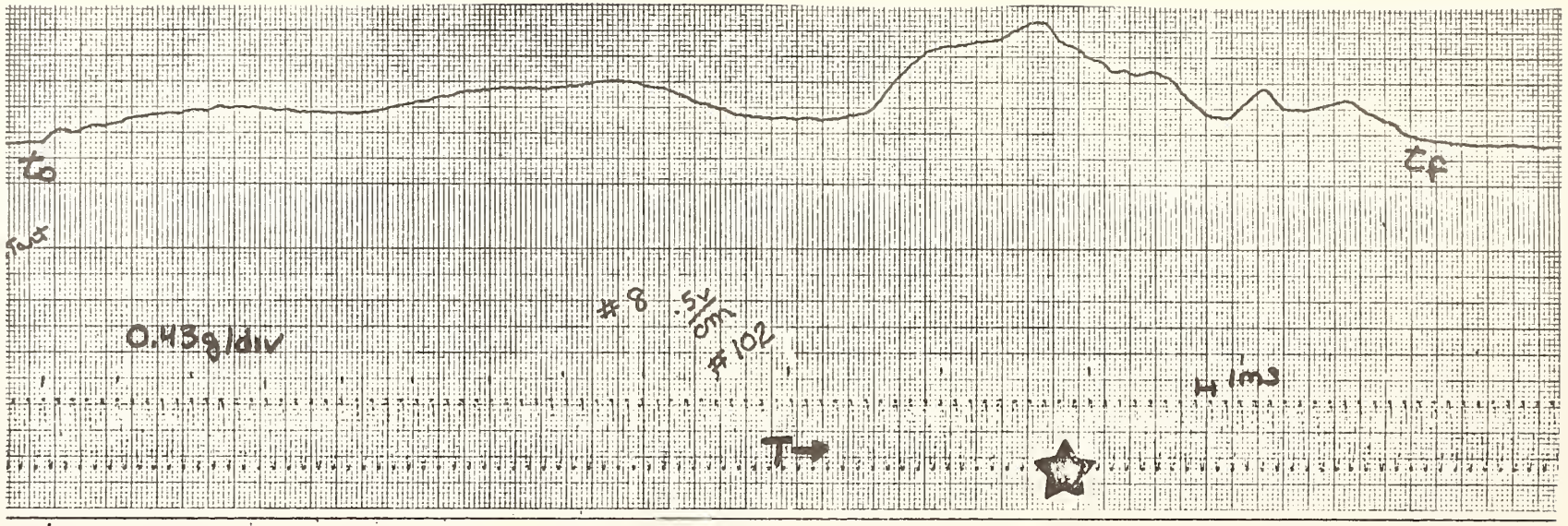
	Area	St. Area	Height of Ref. Curve	Height of Cal. Curve	Cal. g's	$\bar{g}$	Δt	Peak g's	Δ(MV)
	96	255							
#1	102	261	24	20	8.64	4.0	95	10.4	850
	99	258							
	86	226							
#2	83	220	19	15	7.20	3.5	91	9.1	711
	85	223							
	97	271							
#3	102	268	24	20	8.52	3.7	92	10.2	778
	99	269							

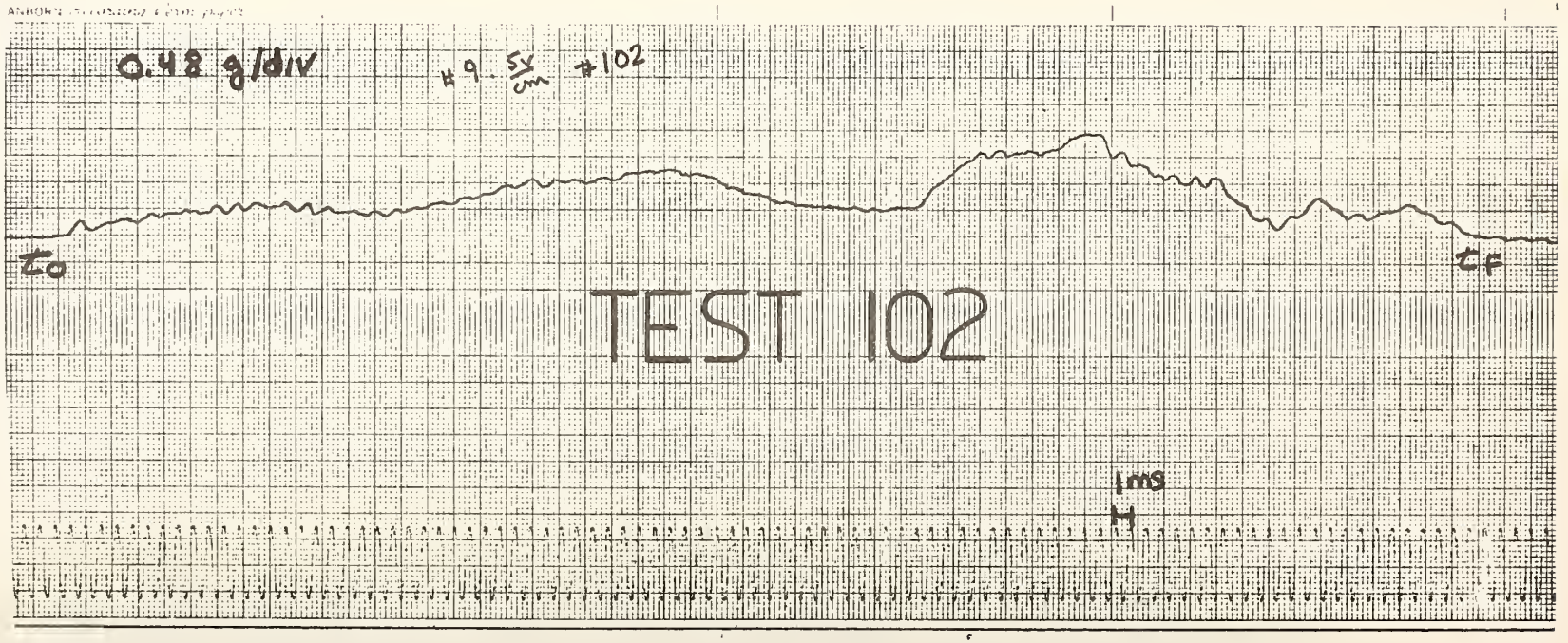
$$\frac{1}{\Delta t}\int_0^{\Delta t} gdt = \frac{\text{Area}}{\text{St. Area}} * \text{Div.} * \frac{\text{Cal. g's}}{\text{Cal. Div.}}$$

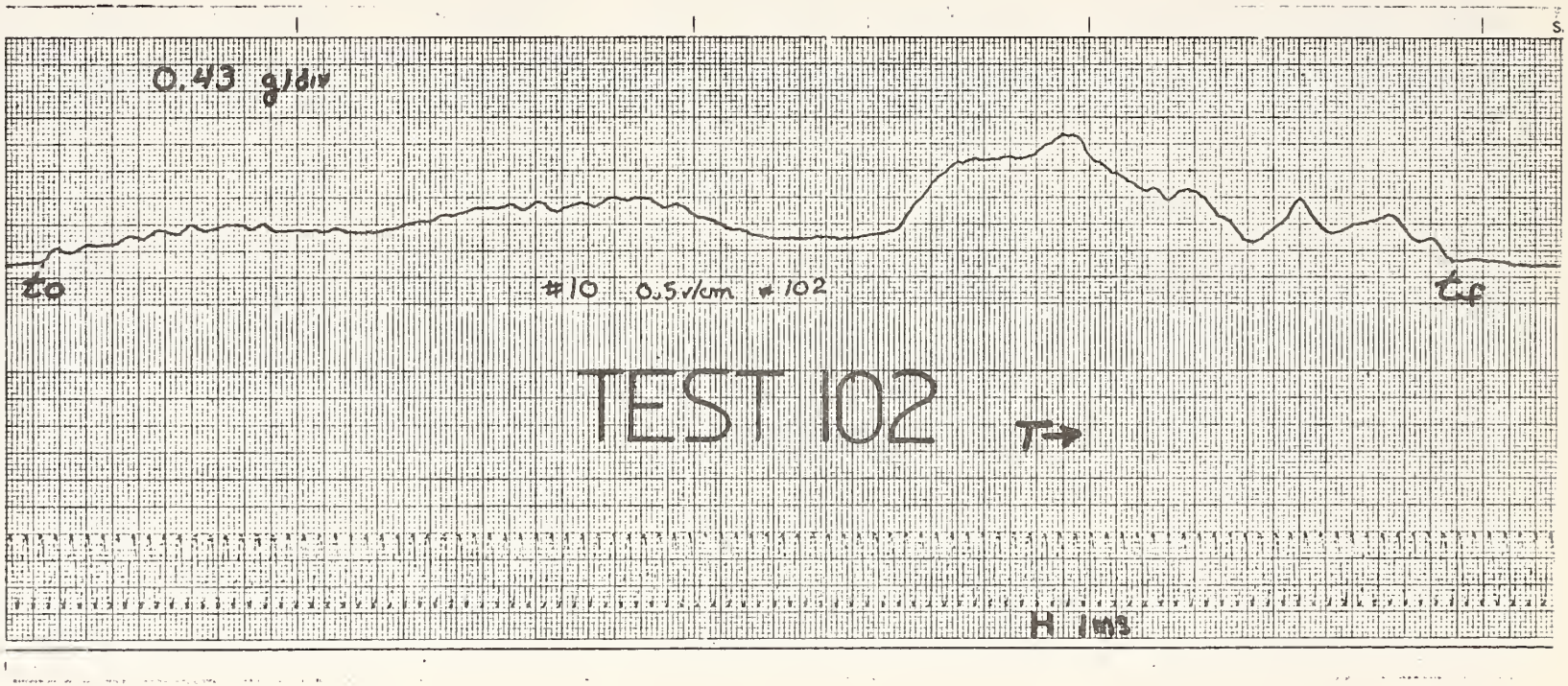
MΔV =780 lb-sec.

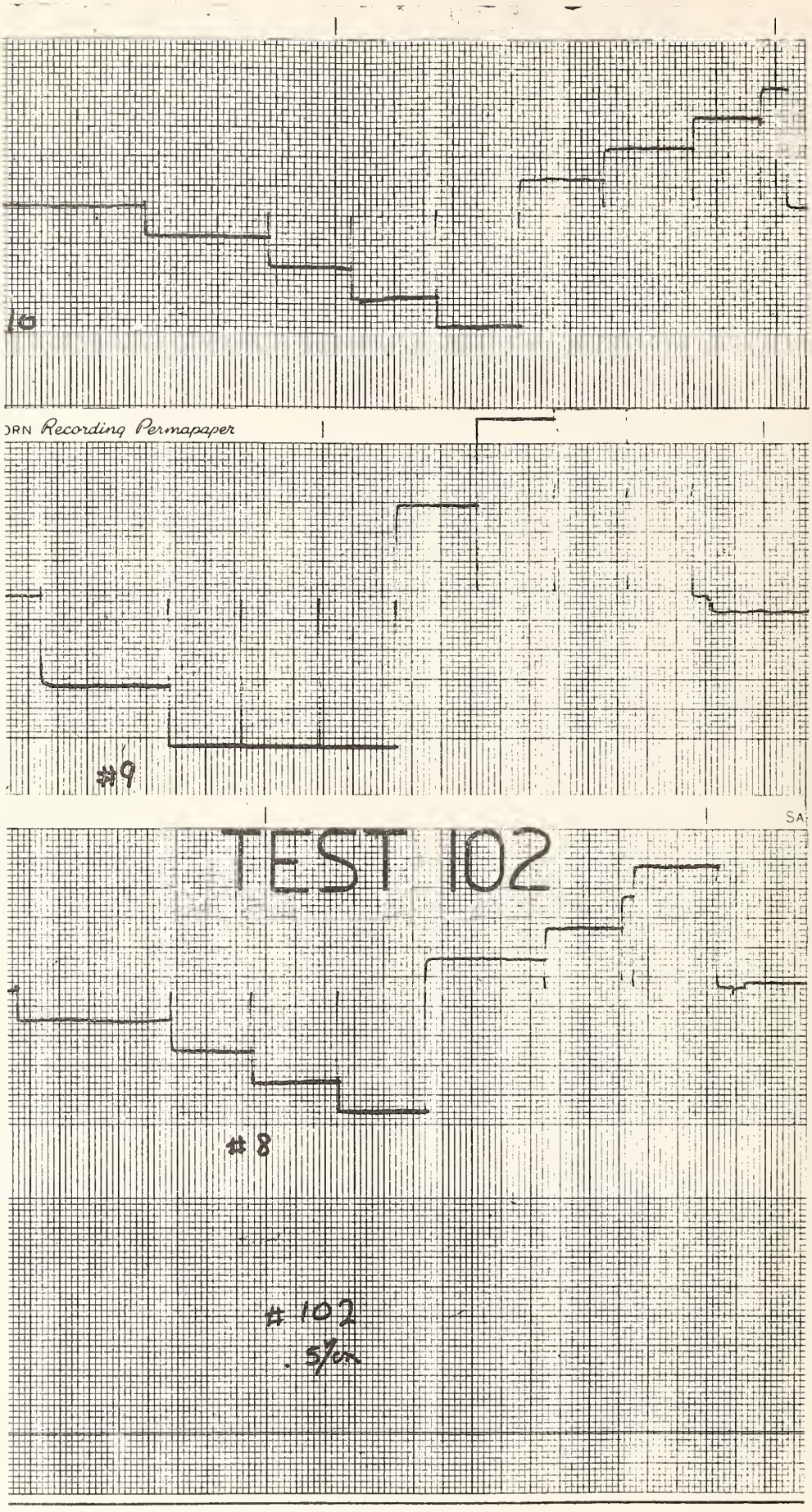
$$M\Delta V = W\int_0^{\Delta t} gdt$$

DATE 4/14/75 JWA


0.43g/div
#8 .5v/cm #102
1 ms
T→


0.48 g/div
#9 .5v/cm #102
TEST 102
1 ms


0.43 g/div
#10 0.5 v/cm #102
TEST 102
T→
H ms


10
ORN Recording Permapaper
#9
TEST 102
#8
#102
5/m

FHWA/ENSCO IMPACT TEST FACILITY
TEST REQUEST

Test No. 103

Pole/Support 30' alum Lum. Shoe base

Description of Setup: _____

Camera: Required yes [✓] no [ ]

Film Color [ ] B&W [✓]

Min. Speed _____

Max. Speed 800

Signals to be Recorded:

a. Accelerometers yes [✓] no [ ]

b. Strain gauges yes [ ] no [✓]

c. Speed transducers yes [ ] no [✓]

d. Other _____

Crush Characteristics:

Honeycomb #1 130 psi 3."2

#2 230 psi 4."5

#3 320 psi 8."

Initial Speed: 20 mph

Mass (weight of pendulum mass): 2250 lbs.

Comments:

FHWA/ENSCO IMPACT TEST FACILITY

Test No. 103 Date: 4/12/75 Weather: Good

Personnel Present: JWA, RPO

1. POWER

Circuit breakers on

1	✓	2	✓	3	✓
4	✓	8	✓	10	✓
11	✓	13	✓	14	✓

2. RELEASE HOOK

Attached ✓ Plugged In ✓ Switch On ✓

3. ACCELEROMETERS

Mounted Correctly ✓

#1 Connected ✓ 15 g's

#2 Connected ✓ 50 g's

#3 Connected ✓ 15 g's

Mounting Pattern of Pendulum Mass (Viewed from Rear)

2

1 3

J-Box Connectors tightened ✓

J-Box Cable connected to Control Box ✓

#1 10 volts Balanced [✓] Excitation [✓] Amp. Bal. [✓]

100 gain # 8 channel into Tape Recorder

#2 10 volts Balanced [✓] Excitation [✓] Amp. Bal. [✓]

300 gain # 9 channel into Tape Recorder

#3 10 volts Balanced [✓] Excitation [✓] Amp. Bal. [✓]

100 gain # 10 channel into Tape Recorder

4. SPEED TRANSDUCERS N/A

Connected correctly to reference cell [ ]

Connectors on reference cell correct [ ]

Slots lined up [ ]

Distance between first two _____ ft.

Distance between second two _____ ft.

Distance between sets _____ ft.

Connected correctly to control box [ ]

Control box on [ ]

Cable from RCDR to channel _____ on tape recorder

Cable from #1 to INPUTA on freq. counter [ ]

Frequency counter turned on [ ]

Sensitivity on [ ]

#1 recorded on channel _____

#2 recorded on channel _____

5. CAMERA

PPS Dial 80 Mult Switch 10

Speed Reducer H Servo Brake L

Drag Brake 30 F Setting 8 Film ASA 400

Light meter reading 15.5 Film B&W

Film correct [✓] Prism correct [✓] Trip switch [✓]

Camera on stop [✓] Timing light on [✓] 100 pulses/sec

Balanced [✓] Remote cable on [✓] Power cable on [✓]

Focus setting 50

View portal correct [✓]

6. CRUSH CHARACTERISTICS

Honeycomb: #1 130 psi 3."2 Vertical Dimension

#2 230 psi 4."5

#3 320 psi 8"

7. POLE Type: 30' alum shoe base

Set up [✓] Torqued exactly [✓] Torque — ft-lbs.

8. TIMING LINES

Frequency 1 K hz Voltage (peak to peak) 10 volts

Recorded on channel 1 input to tape recorder

9. TAPE RECORDER Tape # 001A

Speed 60 ips

Start of calibration 820

End of calibration 860 Meter Setting

Start of Test 860

Calibration signals recorded [✓]

10. MASS

Weight 2250 lbs.

Correct height [✓] Est. initial velocity 20 mph

Accelerometer cables out of danger [✓]

11. LAST SECOND ITEMS

Arm control box ☐

Reset frequency counter ☐

Initial # of Pulses (vis)	-
Initial # of Pulses (rec)	-
Final # of Pulses (rec)	-
Impact meter reading	-
Final meter reading	889
Correction factor for height	--
Amount of crush	-

Remarks:

Unable to measure crush

TEST # 103

DATA REDUCTION
FHWA/ENSCO IMPACT TEST FACILITY

1. Speed Transducers

A) Initial pulses _____ → _____ fps = _____ mph

B) Final pulses _____ :Cor. Factor _____ → _____ fps = _____ mph

Weight of mass = 2250 lbs.

ΔMV = (weight /32.2) x (a-b) lb-sec

= _____ lb-sec

2. Accelerometers

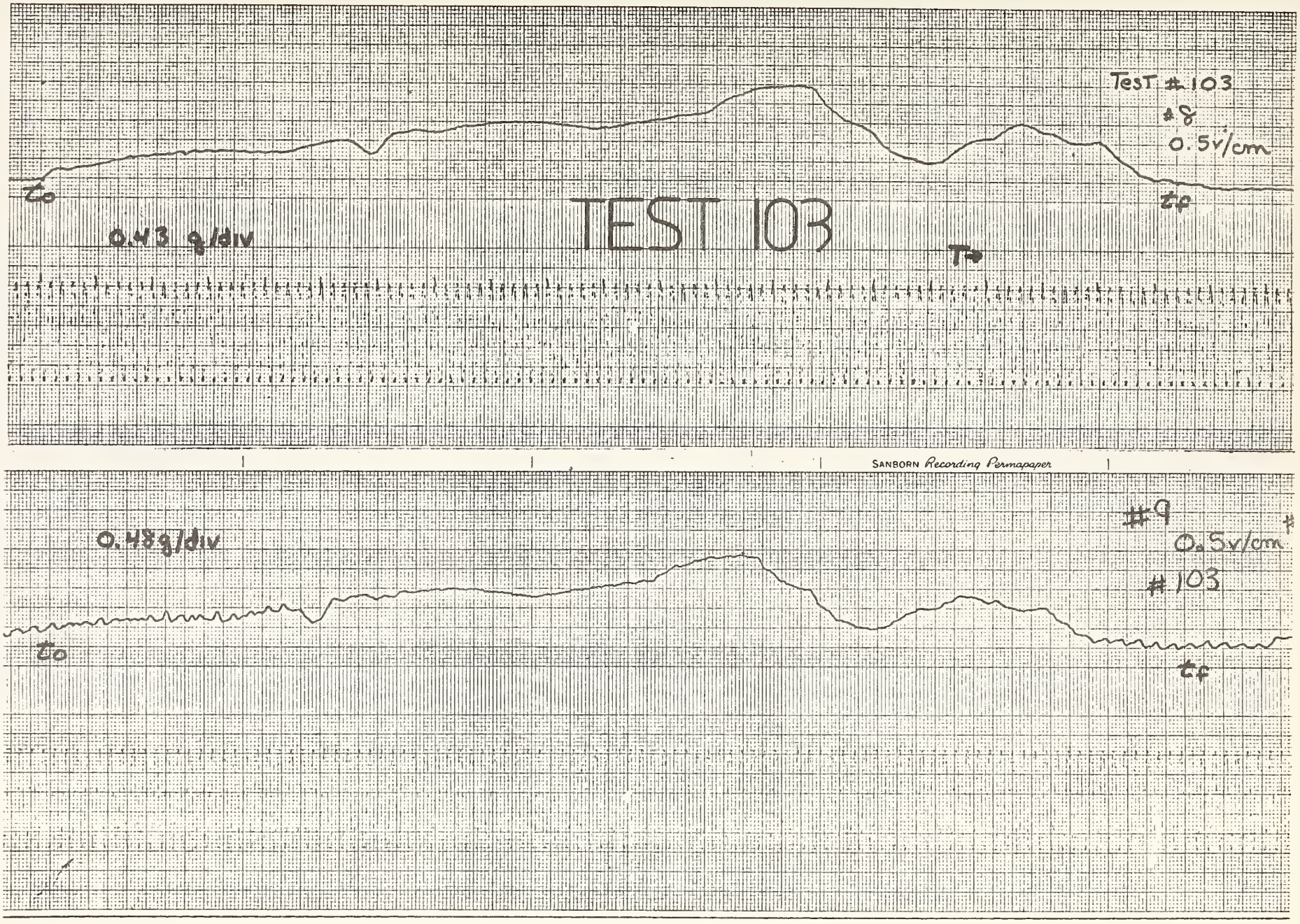
	Area	St. Area	Height of Ref. Curve	Height of Cal. Curve	Cal. g's	g Δt	Peak g's	Δ(MV)
	142	296						
# #1	136	292	25	20	8.64	5.1 101	10.9	1160
	139	294						
	133	301						
# #2	139	300	23	15	7.20	5.0 103	11.0	1160
	136	300						
	150	313						
# #3	144	319	27	20	8.52	5.3 103	11.1	1240
	147	316						

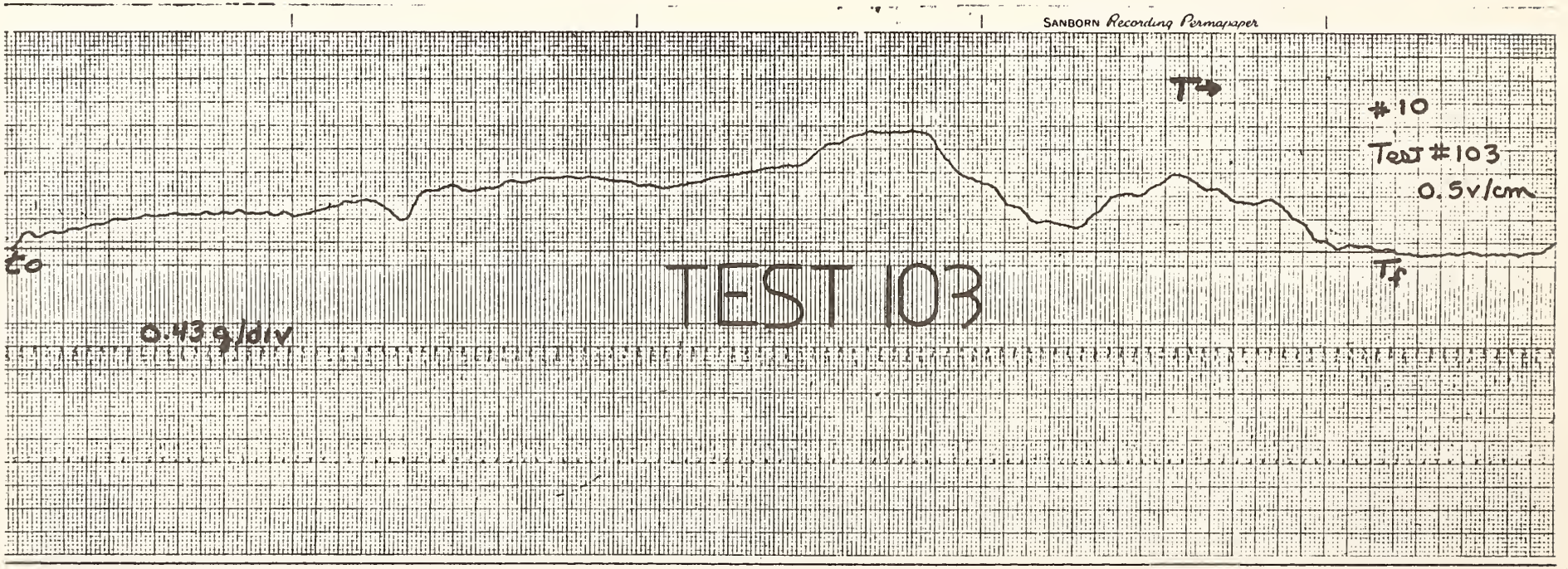
$$\frac{1}{\Delta t}\int_0^{\Delta t} g\,dt = \frac{\text{Area}}{\text{St. Area}} * \text{Div.} * \frac{\text{Cal. g's}}{\text{Cal. Div.}}$$

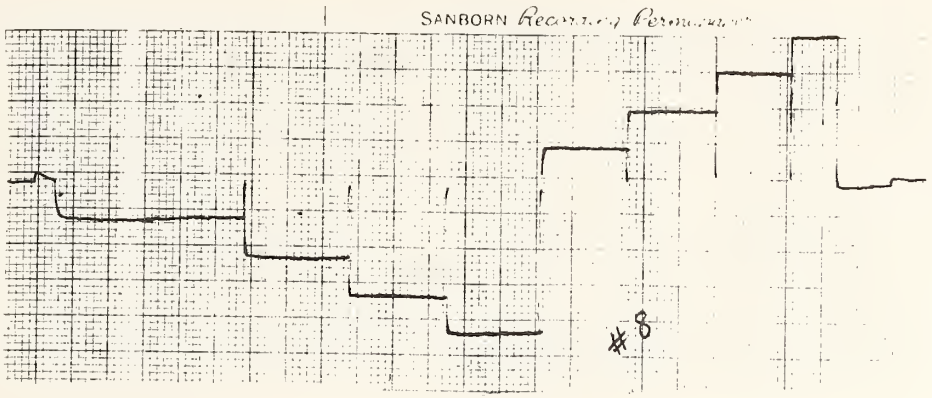
$M\Delta V = 1187$ lb/sec

$$M\Delta V = W\int_0^{\Delta t} g\,dt$$

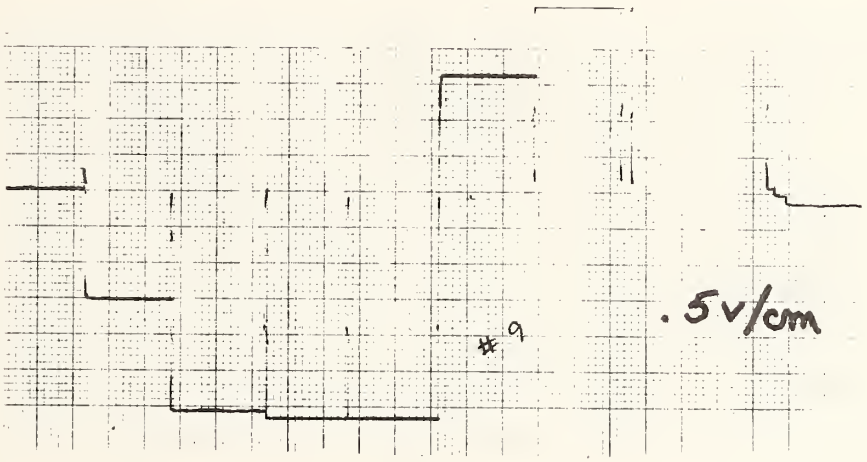
DATE 4/14/75 JWA

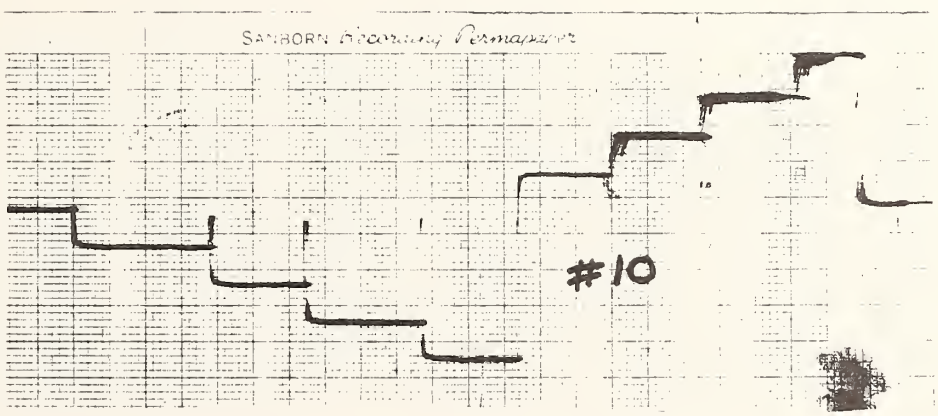

TEST 103
Test #103
#8
0.5v/cm
0.43 g/div
To
Tf
T
SANBORN Recording Permapaper
#9
0.5v/cm
#103
0.489/div
To
Tf


SANBORN Recording Permapaper
T→
#10
Test #103
0.5v/cm
t_o
T_f
TEST 103
0.43 g/div



TEST 103





FHWA/ENSCO IMPACT TEST FACILITY
TEST REQUEST

Test No. 104

Pole/Support 30' Alum Lum

Description of Setup: Shoe base
Newly designed honeycomb
comparable to TTI crush

Camera: Required yes [✓] no [ ]

Film Color [ ] B&W [✓]

Min. Speed 400

Max. Speed 800

Signals to be Recorded:

a. Accelerometers yes [✓] no [ ]

b. Strain gauges yes [ ] no [✓]

c. Speed transducers yes [ ] no [✓]

d. Other _____

Crush Characteristics:

Honeycomb #1 130 psi 3."2

#2 230 psi 4."5

#3 320 psi 8

Initial Speed: 20 mph

Mass (weight of pendulum mass): 2250 lbs.

Comments:

FHWA/ENSCO IMPACT TEST FACILITY

Test No. 104 Date: 4/16/75 Weather: Good

Personnel Present: JWA; Len M./FHWA

1. POWER

Circuit breakers on

1	[X]	2	[X]	3	[X]
4	[X]	8	[X]	10	[X]
11	[X]	13	[X]	14	[X]

2. RELEASE HOOK

Attached [X] Plugged In [X] Switch On [X]

3. ACCELEROMETERS

Mounted Correctly [X]

#1 Connected [X] 15 g's

#2 Connected [X] 50 g's

#3 Connected [X] 15 g's

Mounting Pattern of Pendulum Mass (Viewed from Rear)

[2]

[1] [3]

J-Box Connectors tightened [X]

J-Box Cable connected to Control Box [X]

#1 10 volts Balanced [✓] Excitation [✓] Amp. Bal. [✓]

100 gain # 8 channel into Tape Recorder

#2 10 volts Balanced [✓] Excitation [✓] Amp. Bal. [✓]

300 gain # 9 channel into Tape Recorder

#3 10 volts Balanced [✓] Excitation [✓] Amp. Bal. [✓]

100 gain # 10 channel into Tape Recorder

4. SPEED TRANSDUCERS N/A

Connected correctly to reference cell [ ]

Connectors on reference cell correct [ ]

Slots lined up [ ]

Distance between first two _____ ft.

Distance between second two _____ ft.

Distance between sets _____ ft.

Connected correctly to control box [ ]

Control box on [ ]

Cable from RCDR to channel _____ on tape recorder

Cable from #1 to INPUTA on freq. counter [ ]

Frequency counter turned on [ ]

Sensitivity on [ ]

#1 recorded on channel _____

#2 recorded on channel _____

5. CAMERA

PPS Dial 80 Mult Switch 10

Speed Reducer H Servo Brake L

Drag Brake 30 F Setting F9.5 Film ASA 400

Light meter reading 15.5 Film B&W

Film correct [✓] Prism correct [✓] Trip switch [✓]

Camera on stop [✓] Timing light on [✓] 100 pulses/sec

Balanced [✓] Remote cable on [✓] Power cable on [✓]

Focus setting 50

View portal correct [✓]

6. CRUSH CHARACTERISTICS

Honeycomb: #1 130 psi 3."2 Tapered

#2 230 psi 4."5 Tapered

#3 320 psi 8"

7. POLE Type: Alum Shoe Lum

Set up [✓] Torqued exactly [✓] Torque ___ ft-lbs.

8. TIMING LINES

Frequency 1 K hz Voltage (peak to peak) 10 volts

Recorded on channel 1 input to tape recorder

9. TAPE RECORDER Tape # 001A

Speed 60 ips

Start of calibration 900

End of calibration 948 Meter Setting

Start of Test 948

Calibration signals recorded [✓]

10. MASS

Weight 2250 lbs.

Correct height [✓] Est. initial velocity 20 mph

Accelerometer cables out of danger [✓]

11. LAST SECOND ITEMS

Arm control box ☐

Reset frequency counter ☐

Initial # of Pulses (vis)	-
Initial # of Pulses (rec)	----
Final # of Pulses (rec)	----
Impact meter reading	----
Final meter reading	973
Correction factor for height	---
Amount of crush	16"

Remarks:

Honeycomb sequence wrong

230-130-320

TEST # 104

DATA REDUCTION
FHWA/ENSCO IMPACT TEST FACILITY

1. Speed Transducers

A) Initial pulses _____ → _____ fps = _____ mph

B) Final pulses _____ :Cor. Factor _____ → _____ fps = _____ mph

Weight of mass = 2250 lbs.

ΔMV = (weight /32.2) x (a-b) lb-sec

= _____ lb-sec

2. Accelerometers

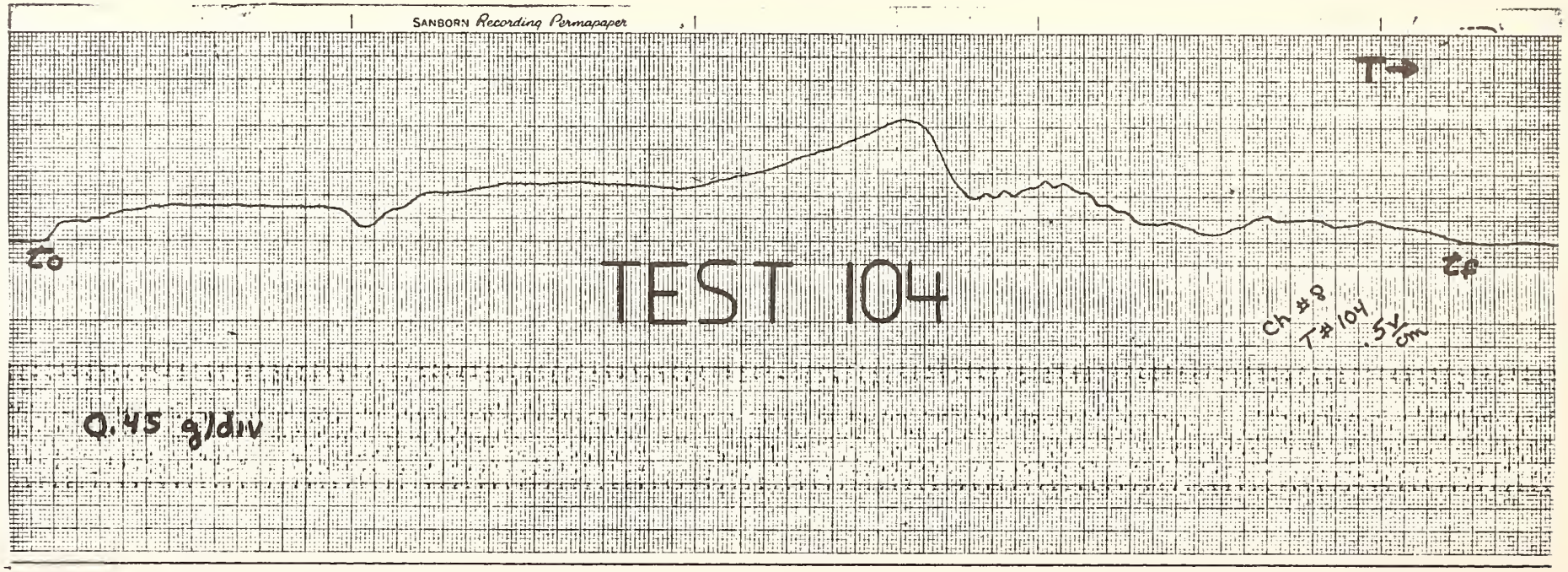
	Area	St. Area	Height of Ref. Curve	Height of Cal. Curve	Cal. g's	g	Δt	Peak g's	Δ(MV)
	1.37	3.56							
#1	1.31	3.40	26.5	19	8.64	4.64	.106	12.0	1106
	1.34	3.48							
	1.25	3.40							
#2	1.28	3.30	25	15	7.2	4.51	.106	12.0	1076
	1.26	3.35							
	1.25	3.62							
#3	1.35	3.52	27	19	8.52	4.40	.105	12.1	1050
	1.30	3.57							

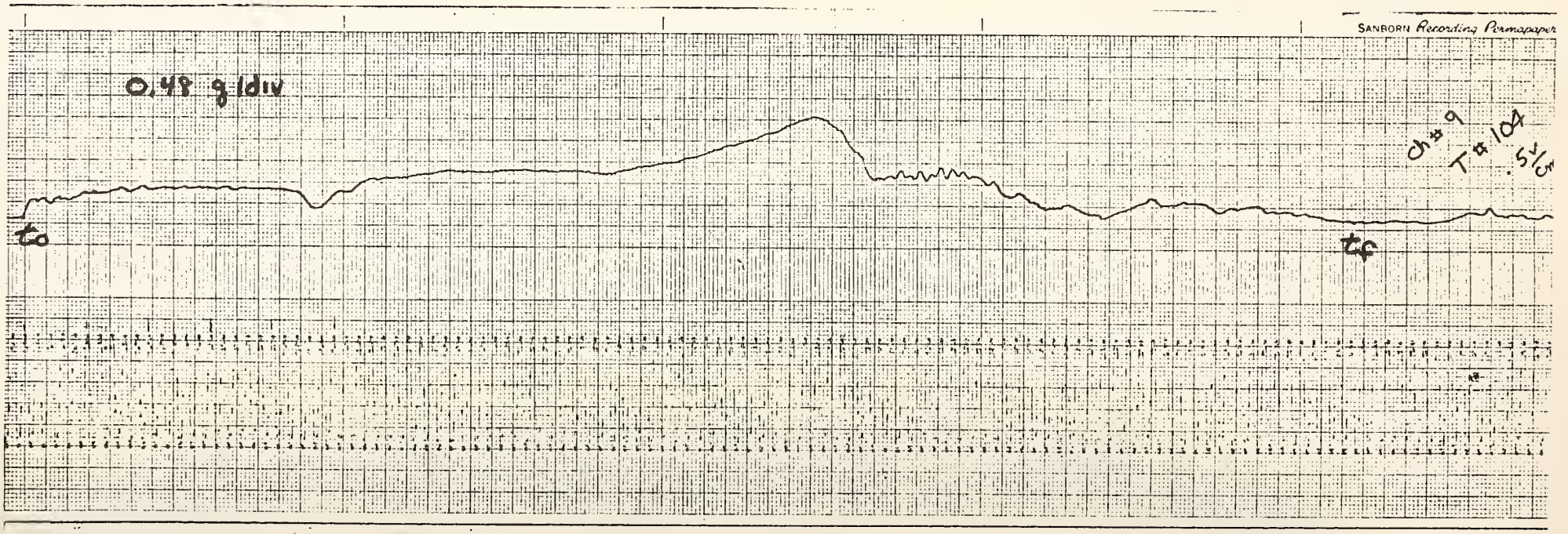
$$\frac{1}{\Delta t}\int_0^{\Delta t} g\,dt = \frac{\text{Area}}{\text{St. Area}} * \text{Div.} * \frac{\text{Cal. g's}}{\text{Cal. Div.}}$$

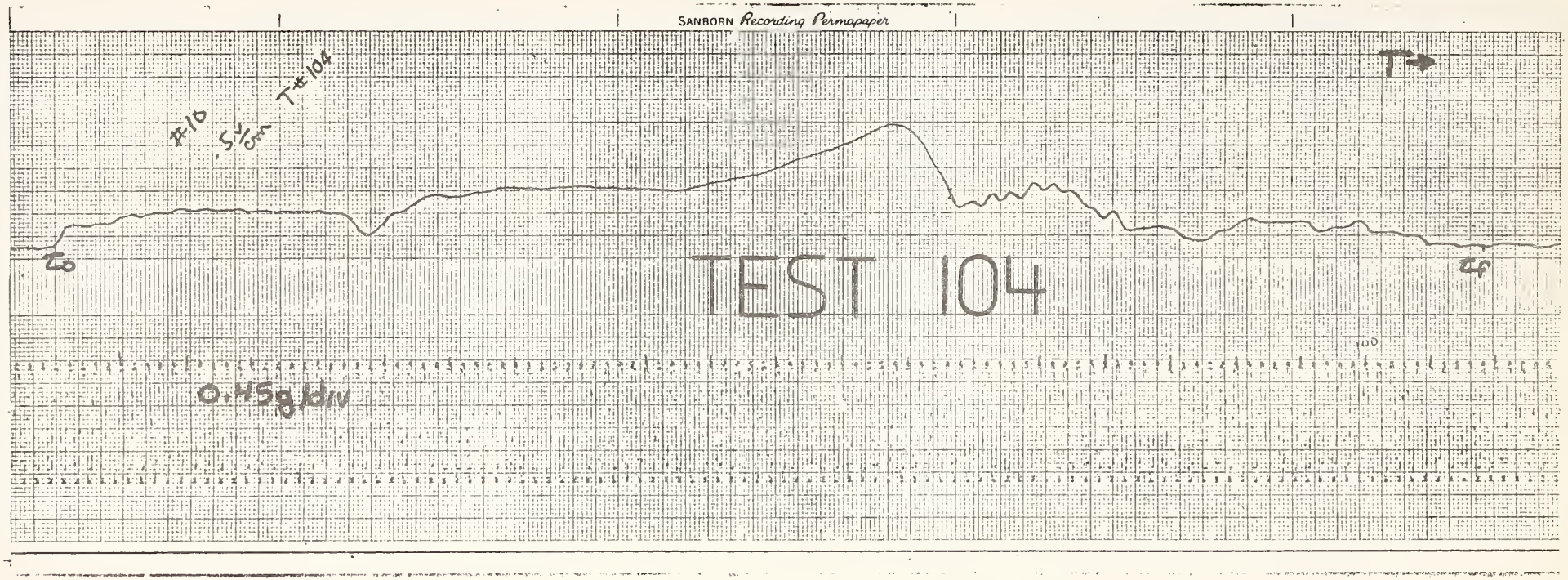
$M\Delta V = W\int_0^{\Delta t} g\,dt$

$M\Delta V$ = 1077 lb sec

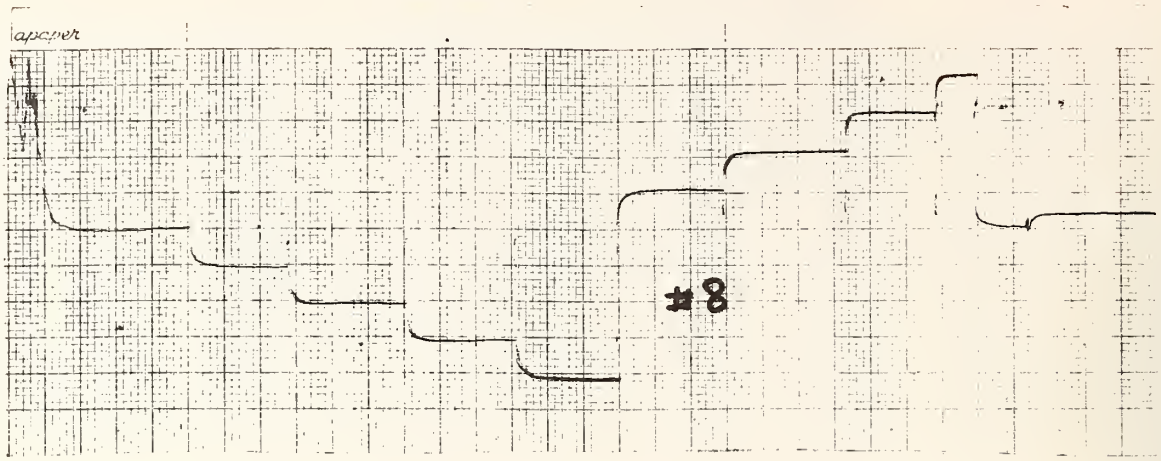
DATE 4/16/75 JWA

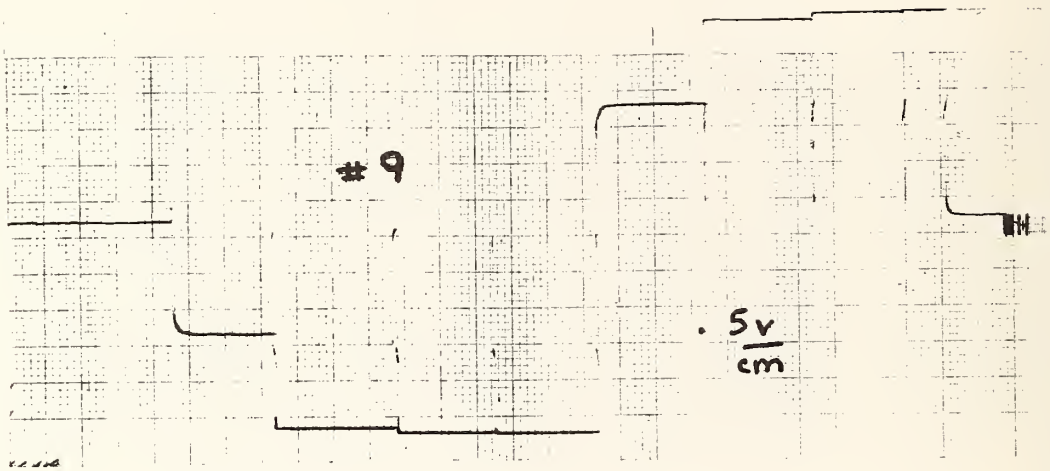

SANBORN Recording Permapaper
T→
t_o
TEST 104
t_f
Ch #8
T#104
.5V/cm
0.45 g/div

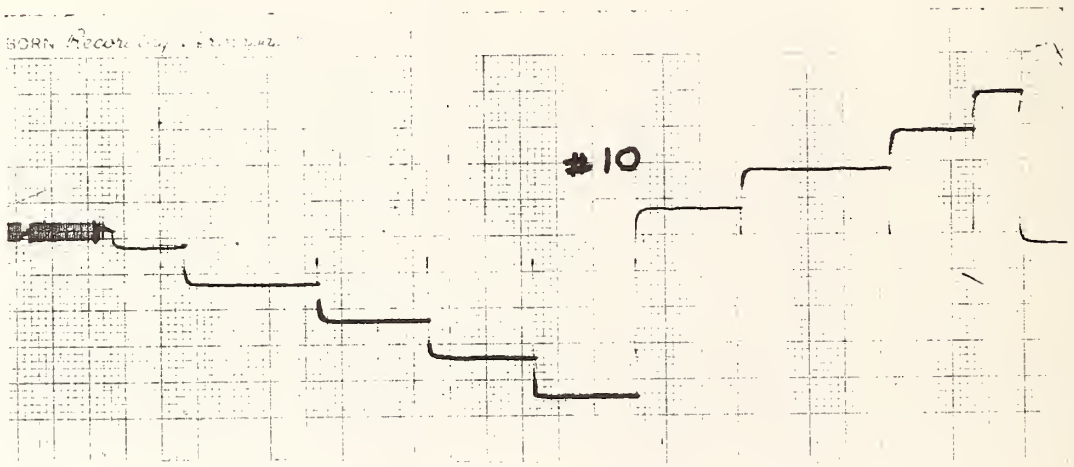

SANBORN Recording Permapaper
0.48 g/div
Ch #9
T#104
t_o
t_f


SANBORN Recording Permapaper
#10 .5 in/cm T#104
T→
TEST 104
0.45g/div

TEST 104







APPENDIX C

TEST DATA FOR DUAL LEGGED SIGN SUPPORTS
(RWF 20) WITH SLIP BASES

FHWA/ENSCO IMPACT TEST FACILITY

TEST REQUEST

Test No. 201

Pole/Support 8WF20

Description of Setup: 8WF20 section 8 feet long on slip base with Hi-Lok shear bolts

Camera: Required yes [X] no [ ]

Film Color [ ] B&W [X]

Min. Speed 200

Max. Speed -

Signals to be Recorded:

a. Accelerometers yes [X] no [ ]

b. Strain gauges yes [ ] no [X]

c. Speed transducers yes [X] no [ ]

d. Other None

Crush Characteristics:

Honeycomb #1 3/16" - 130 psi 8"

#2 1/4" - 230 psi 8"

#3 -

Initial Speed: 20 mph

Mass (weight of pendulum mass): 2250 lbs.

Comments: Initial test and instrumentation checkout

FHWA/ENSCO IMPACT TEST FACILITY

Test No. 201 Date: 10/19/74 Weather: Good

Personnel Present: KC, JWA, RO, GK

1. POWER

Circuit breakers on

1	[X]	2	[X]	3	[X]
4	[X]	8	[X]	10	[X]
11	[X]	13	[X]	14	[X]

2. RELEASE HOOK

Attached [X] Plugged In [X] Switch On [X]

3. ACCELEROMETERS

Mounted Correctly [X]

#1 Connected [X] 15 g's

#2 Connected [X] 50 g's

#3 Connected [X] 50 g's

Mounting Pattern of Pendulum Mass (Viewed from Rear) [2] [3] [1]

J-Box Connectors tightened [X]

J-Box Cable connected to Control Box [X]

#1 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

1000 gain # 8 channel into Tape Recorder

#2 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

1000 gain # 9 channel into Tape Recorder

#3 5 volts Balanced [X] Excitation [X] Amp. Bal. [X]

1000 gain # 10 channel into Tape Recorder

4. SPEED TRANSDUCERS

Connected correctly to reference cell [X]

Connectors on reference cell correct [X]

Slots lined up [X]

Distance between first two 2.0 ft.

Distance between second two 2.0 ft.

Distance between sets ≈ 5 ft.

Connected correctly to control box [X]

Control box on [X]

Cable from RCDR to channel - on tape recorder

Cable from #1 to INPUTA on freq. counter [X]

Frequency counter turned on [X]

Sensitivity on [X]

#1 recorded on channel —

#2 recorded on channel —

5. CAMERA

PPS Dial 30 Mult Switch 10

Speed Reducer H Servo Brake L

Drag Brake 30 F Setting 4. Film ASA 200

Light meter reading 15 Film Black & White

Film correct [X] Prism correct [X] Trip switch [X]

Camera on stop [X] Timing light on [ ] Not used pulses/sec

Balanced [X] Remote cable on [X] Power cable on [X]

Focus setting —

View portal correct [X]

6. CRUSH CHARACTERISTICS

Honeycomb: #1 3/16 - 130 psi

#2 1/4 - 230 psi

#3

7. POLE Type: 8WF20

Set up [X] Torqued exactly [X] Torque 120 ft-lbs.

8. TIMING LINES Not Used

Frequency _____ hz Voltage (peak to peak) _____ volts

Recorded on channel _____ input to tape recorder

9. TAPE RECORDER Tape # 001

Speed .60 ips

Start of calibration 000

End of calibration 089 Meter Setting

Start of Test 089

Calibration signals recorded [X]

10. MASS

Weight 2250 lbs.

Correct height [X] Est. initial velocity 20 mph

Accelerometer cables out of danger [X]

11. LAST SECOND ITEMS

Arm control box [X]

Reset frequency counter [X]

Initial # of Pulses (vis)	1042
Initial # of Pulses (rec)	1042
Final # of Pulses (rec)	1256
Impact meter reading	69
Final meter reading	100
Correction factor for height	.95
Amount of crush	6-3/8"

Remarks:

Mounting plate for accelerometer had only two of the three bolts clamping it to the pendulum mass. The result was a ringing of the accelerometers.

TEST # 201

DATA REDUCTION
FHWA/ENSCO IMPACT TEST FACILITY

1. Speed Transducers

A) Initial pulses 1042 → 30.0 fps = 20.45 mph

B) Final pulses 1256 :Cor. Factor .95 → 26.18 fps = 17.85 mph

Weight of mass = 2250 lbs.

ΔMV = (weight /32.2) x (a-b) lb-sec

= 266 lb-sec

2. Accelerometers

	Area	St. Area	Div.	Cal. Div.	Cal. g's	$\frac{1}{\Delta t}\int_0^{\Delta t} gdt$	Δt	$W\int_0^{\Delta t} gdt$
#1	—							
#2	—							
#3	.810	4.26						
	1.050	4.05	32	8	8.52	7.55	27	458
	.925	4.17						

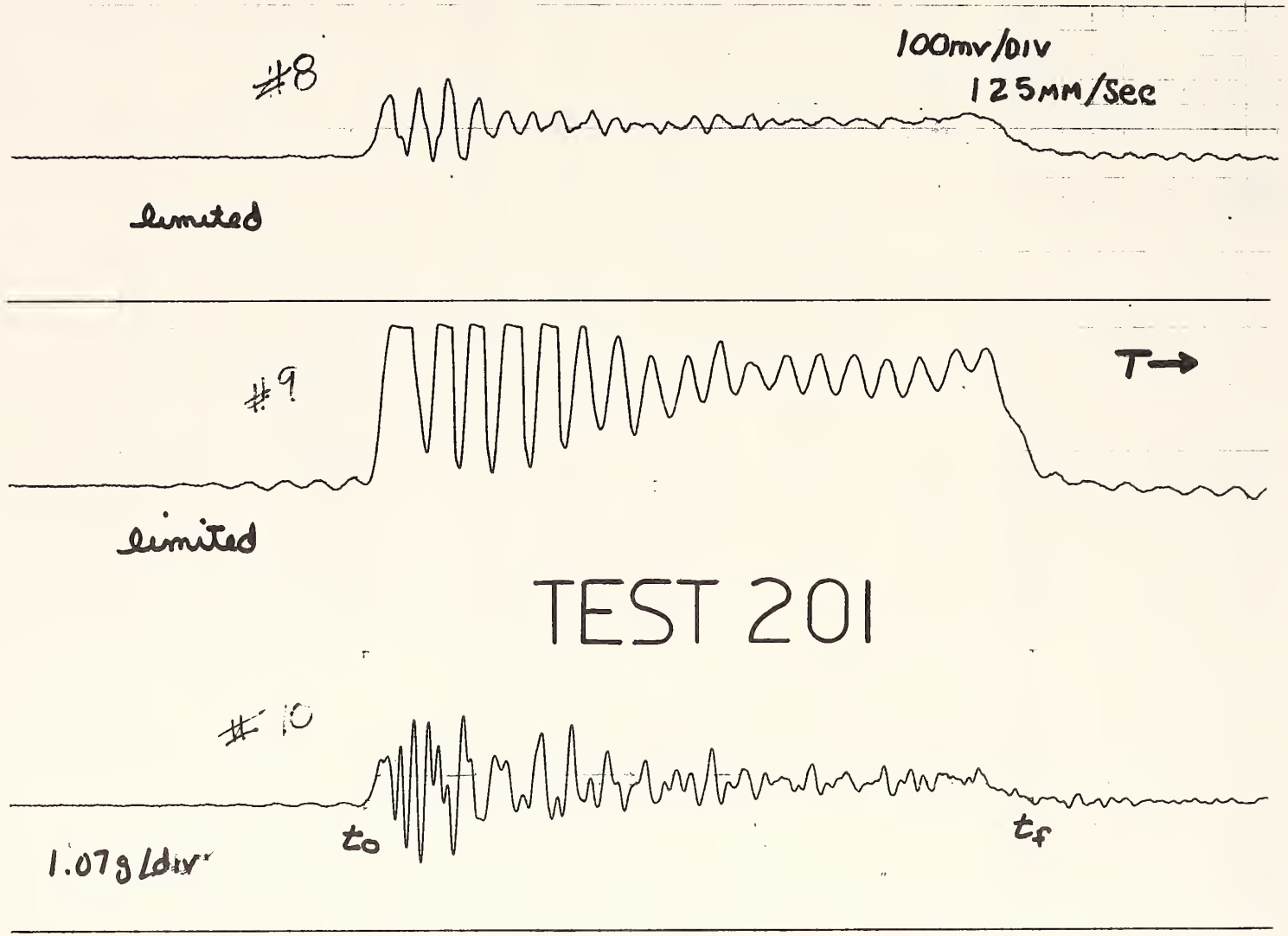
Accelerometer has much ringing

$$\frac{1}{\Delta t}\int_0^{\Delta t} gdt = \frac{\text{Area}}{\text{St. Area}} * \text{Div.} * \frac{\text{Cal. g's}}{\text{Cal. Div.}}$$

$M\Delta V = W\int_0^{\Delta t} gdt$

$M\Delta V$ = 362 lb-se

DATE Oct 3, 1974 JWA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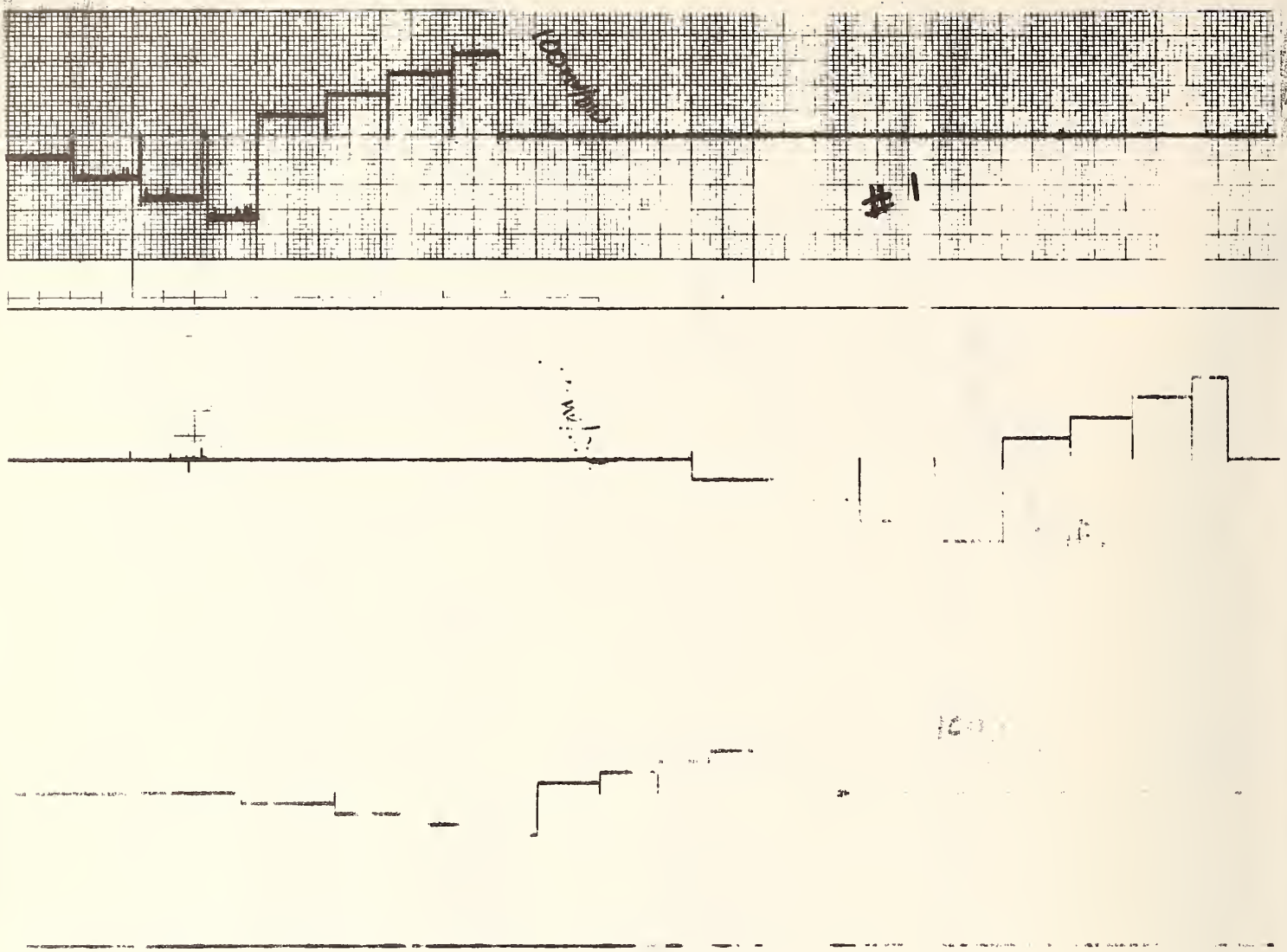
100mv/DIV
125MM/Sec
limited
#9
T→
limited
TEST 201
#10
1.07g/div
to
tf



TEST 201

Test No. 202

Pole/Support 8WF20

Description of Setup: 8WF20 8 foot section with slip base and Hi-Lok bolts

Camera: Required yes [X] no [ ]

Film Color [X] B&W [ ]

Min. Speed 200

Max. Speed -

Signals to be Recorded:

a. Accelerometers yes [X] no [ ]

b. Strain gauges yes [ ] no [X]

c. Speed transducers yes [X] no [ ]

d. Other None

Crush Characteristics:

Honeycomb #1 3/16" - .001/5052 130 psi 8"

#2 1/4" - .002/5052 230 psi 8"

#3 -

Initial Speed: 20

Mass (weight of pendulum mass): 2250 lbs.

Comments: Further instrumentation checkout

FHWA/ENSCO IMPACT TEST FACILITY

Test No. 202 Date: 9/25/74 Weather: Good

Personnel Present: JWA, RO

1. POWER

Circuit breakers on

1	[X]	2	[X]	3	[X]
4	[X]	8	[X]	10	[X]
11	[X]	13	[X]	14	[X]

2. RELEASE HOOK

Attached [X] Plugged In [X] Switch On [X]

3. ACCELEROMETERS

Mounted Correctly [X]

#1 Connected [X] 15 g's

#2 Connected [X] 50 g's

#3 Connected [X] 15 g's

Mounting Pattern of Pendulum Mass (Viewed from Rear)

[2]

[1] [3]

J-Box Connectors tightened [X]

J-Box Cable connected to Control Box [X]

#1 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

1000 gain # 8 channel into Tape Recorder

#2 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

1000 gain # 9 channel into Tape Recorder

#3 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

1000 gain # 10 channel into Tape Recorder

4. SPEED TRANSDUCERS

Connected correctly to reference cell [X]

Connectors on reference cell correct [X]

Slots lined up [X]

Distance between first two 2.0 ft.

Distance between second two 2.0 ft.

Distance between sets - ft.

Connected correctly to control box [X]

Control box on [X]

Cable from RCDR to channel - on tape recorder

Cable from #1 to INPUTA on freq. counter [X]

Frequency counter turned on [X]

Sensitivity on [X]

#1 recorded on channel -

#2 recorded on channel -

5. CAMERA

PPS Dial 80.0 Mult Switch 10.0

Speed Reducer H Servo Brake L

Drag Brake 30 F Setting 4 Film ASA 80

Light meter reading 15.5 Film Color

Film correct [X] Prism correct [X] Trip switch [X]

Camera on stop [X] Timing light on [X] 100 pulses/sec

Balanced [X] Remote cable on [X] Power cable on [X]

Focus setting -

View portal correct [X]

6. CRUSH CHARACTERISTICS

Honeycomb: #1 3/16 - .001 130 psi

#2 1/4 - .002 230 psi

#3 -

7. POLE Type: 8WF20

Set up [X] Torqued exactly [X] Torque 120 ft-lbs.

8. TIMING LINES

Frequency 1000 hz Voltage (peak to peak) 10 volts

Recorded on channel 1 input to tape recorder

9. TAPE RECORDER Tape # _____

Speed 60 ips

Start of calibration 475

End of calibration 559 } Meter Setting

Start of Test 559

Calibration signals recorded [X]

10. MASS

Weight 2250 lbs.

Correct height [X] Est. initial velocity 20 mph

Accelerometer cables out of danger [X]

11. LAST SECOND ITEMS

Arm control box [X]

Reset frequency counter [X]

Initial # of Pulses (vis)	-
Initial # of Pulses (rec)	-
Final # of Pulses (rec)	-
Impact meter reading	566
Final meter reading	600
Correction factor for height	-
Amount of crush	8.06

Remarks:

The gain on all three accelerometers was set at 1000. As a result only the 50 g accelerometer provided useful information.

TEST # 202

DATA REDUCTION
FHWA/ENSCO IMPACT TEST FACILITY

1. Speed Transducers

A) Initial pulses ___-___ → _____ fps = ___-___ mph

B) Final pulses ___-___ :Cor. Factor _____ → _____ fps = ___-___ mph

Weight of mass = 2250 lbs.

ΔMV = (weight /32.2) x (a-b) lb-sec

= ___-___ lb-sec

2. Accelerometers

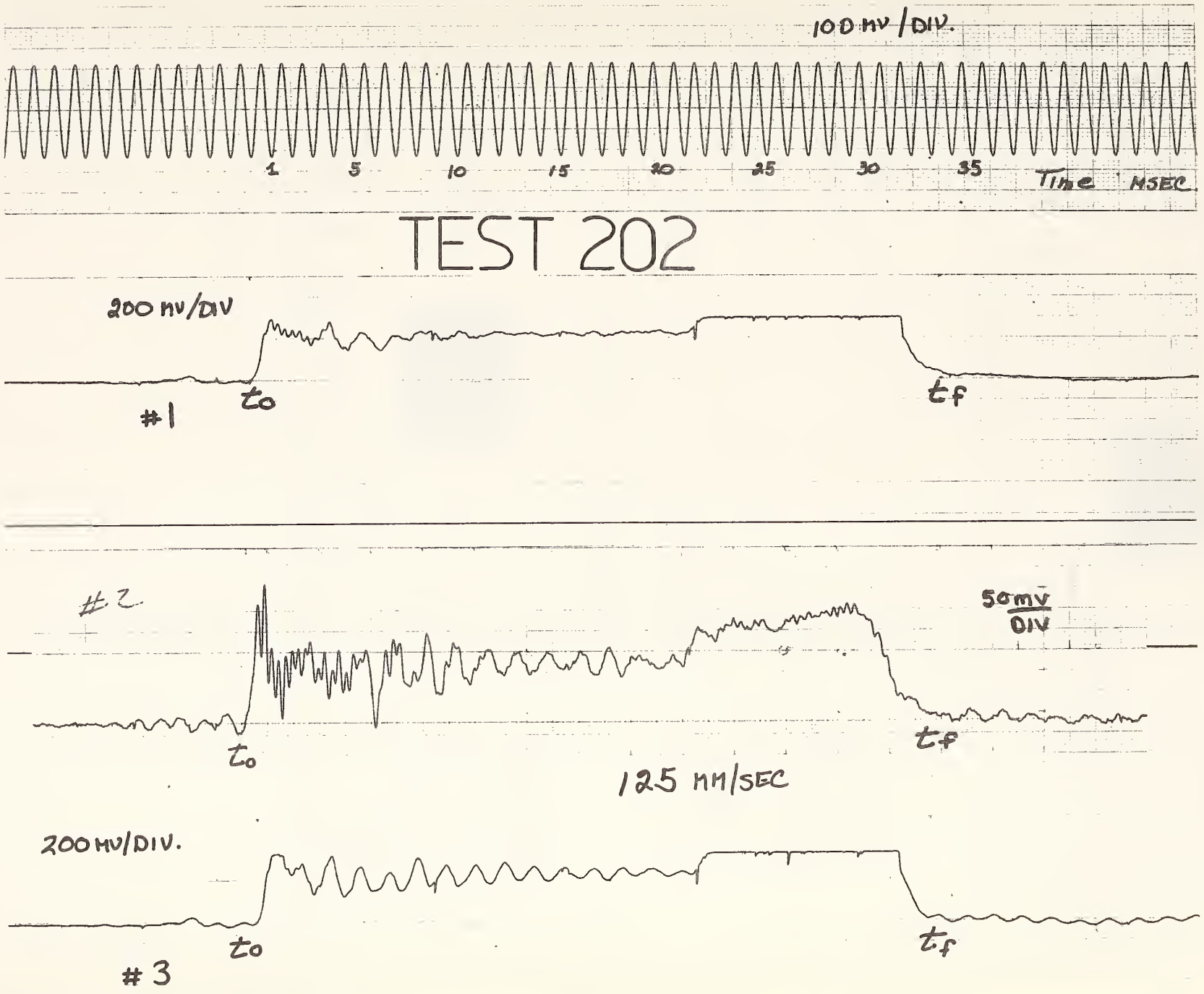
	Area	St. Area	Div.	Cal. Div.	Cal. g's	$\frac{1}{\Delta t}\int_0^{\Delta t} gdt$	Δt	$W\int_0^{\Delta t} gdt$
#1	-							
#2	-							
#3	2.73 2.83 2.78	7.00 7.005 7.00	42	28	7.20	4.29	33.8	326

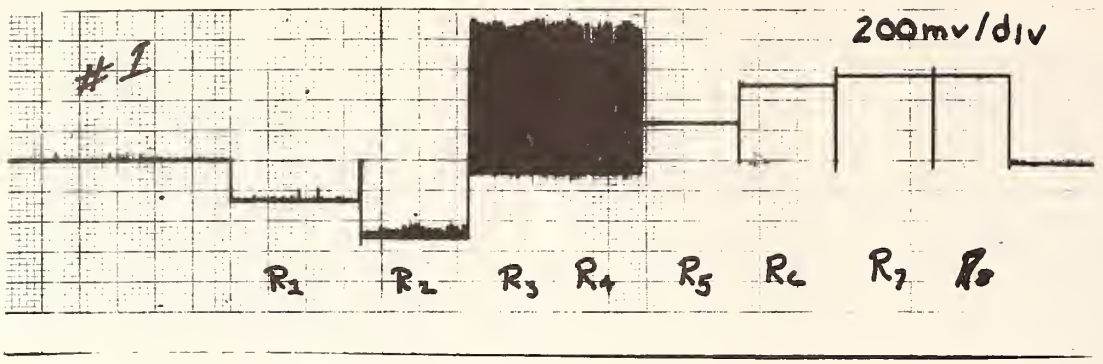
$$\frac{1}{\Delta t}\int_0^{\Delta t} gdt = \frac{\text{Area}}{\text{St. Area}} * \text{Div.} * \frac{\text{Cal. g's}}{\text{Cal. Div.}}$$

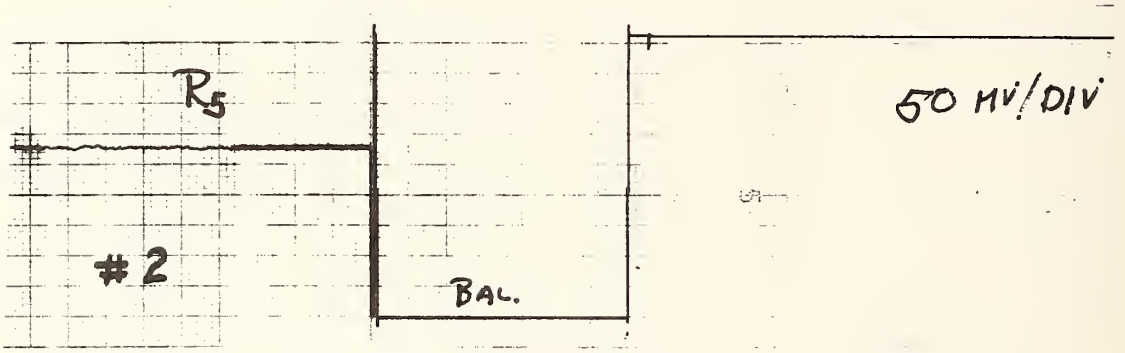
$$M\Delta V = W\int_0^{\Delta t} gdt$$

$M\Delta V$=326lb-sec

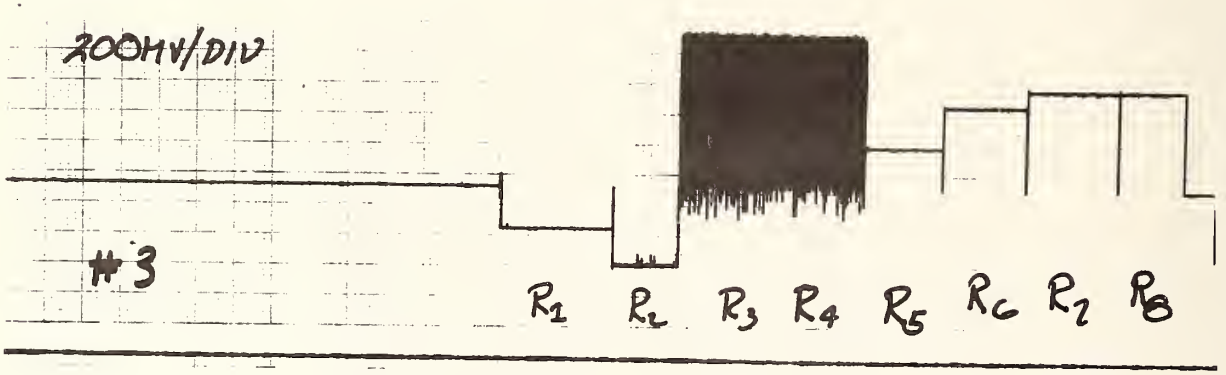
DATE October 4, 1974 JWA


100 mv / DIV.
1
5
10
15
20
25
30
35
Time MSEC
TEST 202
200 mv/DIV
#1
to
tf
#2
50 mv / DIV
to
tf
125 mm/SEC
200 mv/DIV.
#3
to
tf


#1
200mv/div
R1
R2
R3
R4
R5
RC
R7
R8


R5
50 MV/DIV
#2
BAL.

TEST 202


200MV/DIV
#3
R1
R2
R3
R4
R5
RC
R7
R8

FHWA/ENSCO IMPACT TEST FACILITY
TEST REQUEST

Test No. 203

Pole/Support 8WF20

Description of Setup: 8WF20 section 8 feet long slip base with Hi-Lok bolts

Camera: Required yes [X] no [ ]

Film Color [X] B&W [ ]

Min. Speed 200

Max. Speed -

Signals to be Recorded:

a. Accelerometers yes [X] no [ ]

b. Strain gauges yes [ ] no [X]

c. Speed transducers yes [X] no [ ]

d. Other None

Crush Characteristics:

Honeycomb #1 3/16 - .001/5052 130 psi 8"

#2 1/4 - .002/5052 230 psi 8"

#3 -

Initial Speed: 20 mph

Mass (weight of pendulum mass): 2250 lbs.

Comments:

FHWA/ENSCO IMPACT TEST FACILITY

Test No. 203 Date: 10/1/74 Weather: Windy & Bright

Personnel Present: KC, JWA, RO

1. POWER

Circuit breakers on

1	[X]	2	[X]	3	[X]
4	[X]	8	[X]	10	[X]
11	[X]	13	[X]	14	[X]

2. RELEASE HOOK

Attached [X] Plugged In [X] Switch On [X]

3. ACCELEROMETERS

Mounted Correctly [X]

#1 Connected [X] 15 g's

#2 Connected [X] 50 g's

#3 Connected [X] 15 g's

Mounting Pattern of Pendulum Mass (Viewed from Rear)

[2]

[1] [3]

J-Box Connectors tightened [X]

J-Box Cable connected to Control Box [X]

#1 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

300 gain # 8 channel into Tape Recorder

#2 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

300 gain # 9 channel into Tape Recorder

#3 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

300 gain # 10 channel into Tape Recorder

4. SPEED TRANSDUCERS

Connected correctly to reference cell [X]

Connectors on reference cell correct [X]

Slots lined up [X]

Distance between first two 2 ft.

Distance between second two 2 ft.

Distance between sets 7 ft.

Connected correctly to control box [X]

Control box on [X]

Cable from RCDR to channel 2 on tape recorder

Cable from #1 to INPUTA on freq. counter [X]

Frequency counter turned on [X]

Sensitivity on [X]

#1 recorded on channel -

#2 recorded on channel -

5. CAMERA

PPS Dial 60 Mult Switch 10

Speed Reducer H Servo Brake L

Drag Brake 30 F Setting 4 Film ASA 80

Light meter reading 15.5 Film Color

Film correct [X] Prism correct [X] Trip switch [X]

Camera on stop [X] Timing light on [X] 100 pulses/sec

Balanced [X] Remote cable on [X] Power cable on [X]

Focus setting -

View portal correct [X]

6. CRUSH CHARACTERISTICS

Honeycomb: #1 3/16" 130 psi

#2 1/4" 230 psi

#3 -

7. POLE Type: 8WF20

Set up [X] Torqued exactly [X] Torque 120 ft-lbs.

8. TIMING LINES

Frequency 1 Khz Voltage (peak to peak) 10 volts

Recorded on channel 1 input to tape recorder

9. TAPE RECORDER Tape # 001

Speed 60 ips

Start of calibration 800

End of calibration 886 } Meter Setting

Start of Test 886

Calibration signals recorded [X]

10. MASS

Weight 2250 lbs.

Correct height [X] Est. initial velocity 20 mph

Accelerometer cables out of danger [X]

11. LAST SECOND ITEMS

Arm control box [X]

Reset frequency counter [X]

Initial # of Pulses (vis)	1355 (final)
Initial # of Pulses (rec)	-
Final # of Pulses (rec)	1355
Impact meter reading	890
Final meter reading	933
Correction factor for height	.93
Amount of crush	7.87"

Remarks:

TEST # 203

DATA REDUCTION
FHWA/ENSCO IMPACT TEST FACILITY

1. Speed Transducers

A) Initial pulses 1065 → 29.34 fps = 20 mph

B) Final pulses 1355 :Cor. Factor .93 → 24.8 fps = 16.9 mph

Weight of mass = 2250 lbs.

ΔMV = (weight /32.2) x (a-b) lb-sec

= 3 17 lb-sec

2. Accelerometers

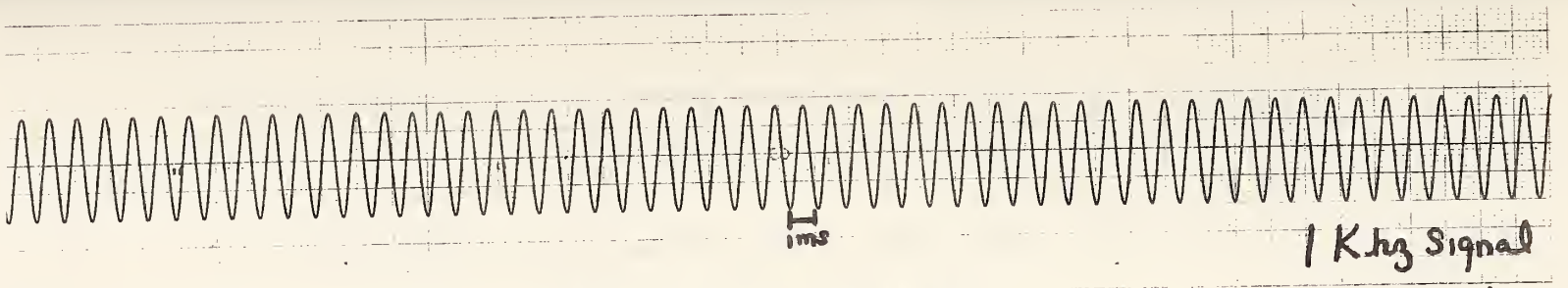
	Area	St. Area	Div.	Cal. Div.	Cal. g's	$\frac{1}{\Delta t}\int_0^{\Delta t} gdt$	Δt	$W\int_0^{\Delta t} gdt$
	2.56	6.64						
#1	2.68	6.72	40	24.5	6.5	4.16	33.0	308
	2.62	6.68						
	1.98	6.10						
#2	2.08	5.96	37.5	20.5	7.2	4.41	32.3	319
	2.02	6.03						
	2.68	6.73						
#3	2.58	6.85	41.5	16.5	4.27	4.17	33.0	309
	2.63	6.77						

$$\frac{1}{\Delta t}\int_0^{\Delta t} gdt = \frac{\text{Area}}{\text{St. Area}} * \text{Div.} * \frac{\text{Cal. g's}}{\text{Cal. Div.}}$$

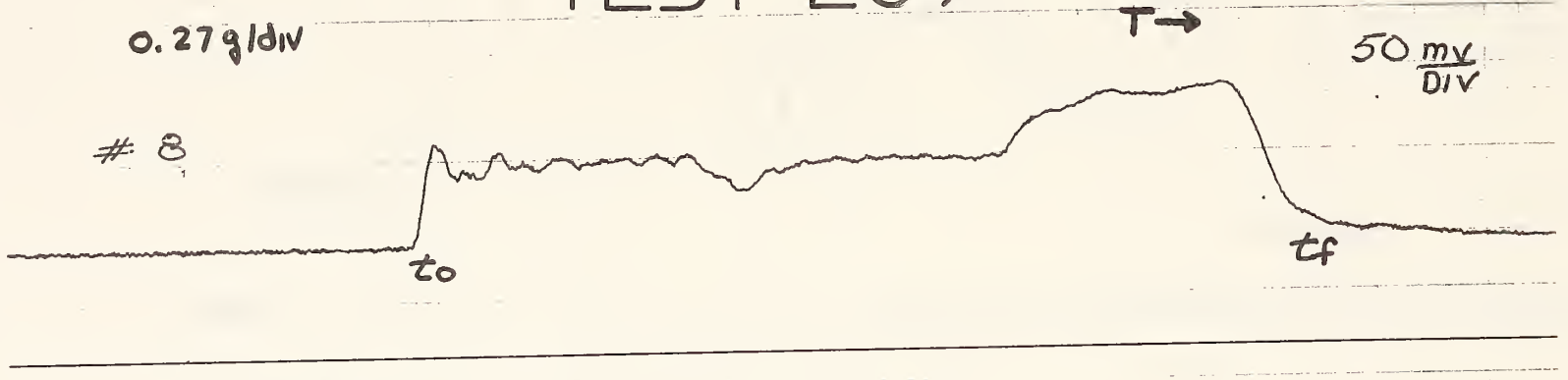
$M\Delta V = 3131$ lb-sec

$$M\Delta V = W\int_0^{\Delta t} gdt$$

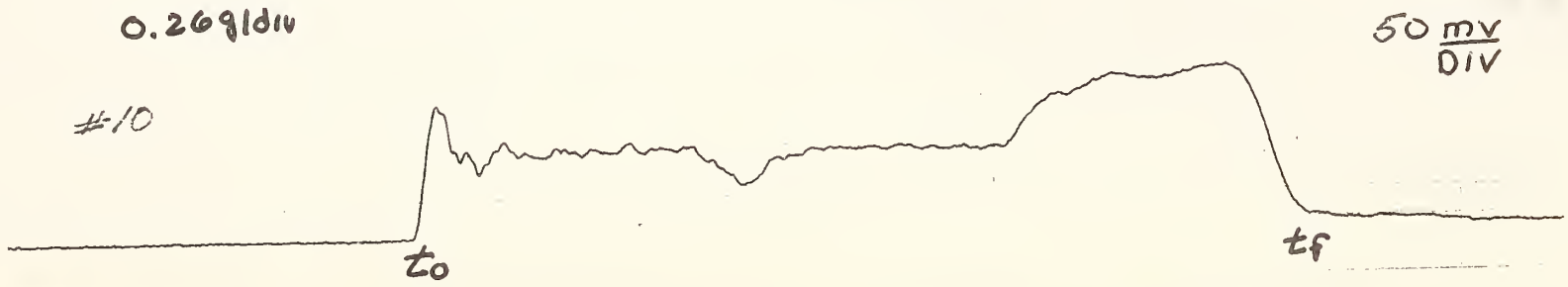
DATE 10/3/74 JWA

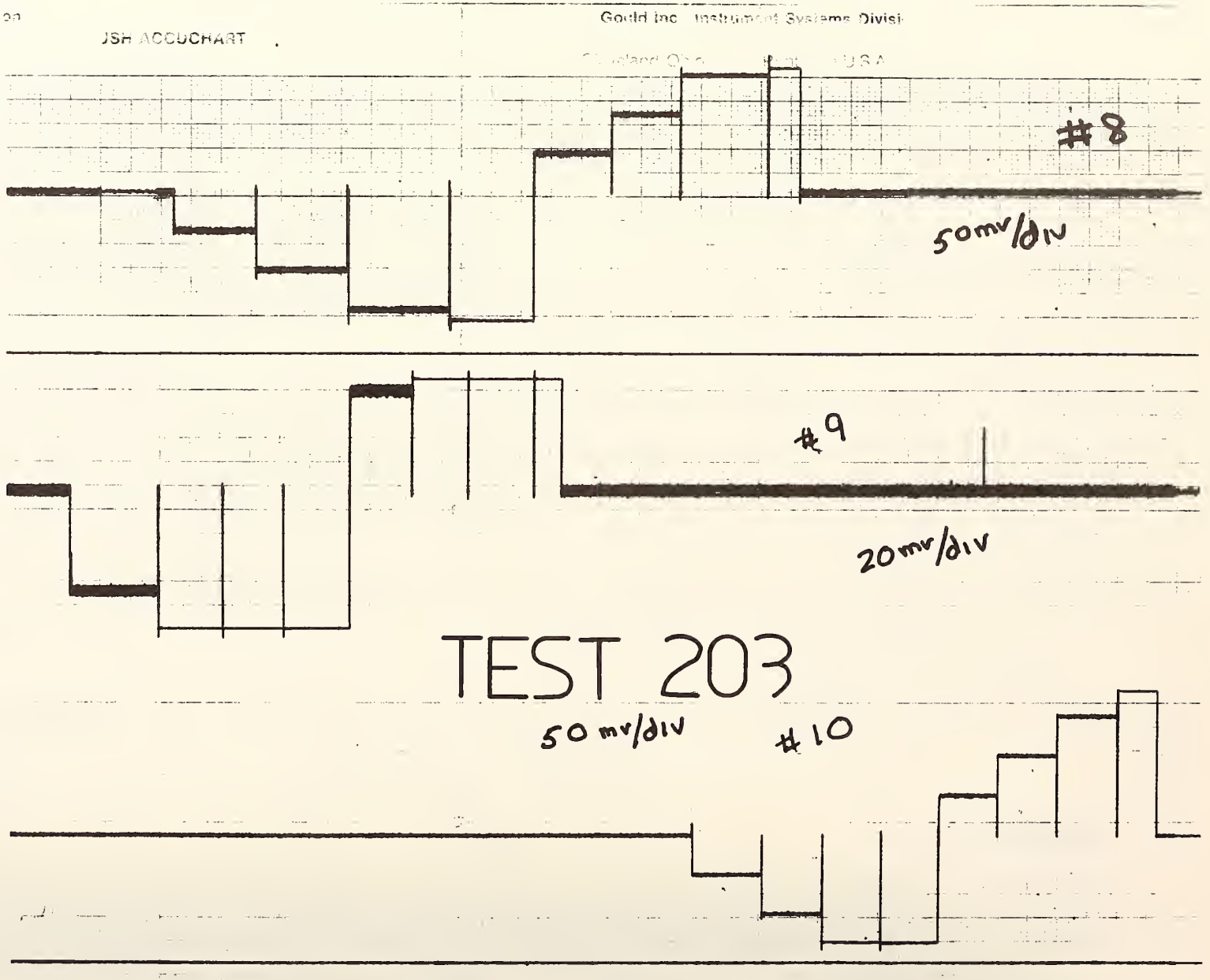

1ms
1 Khz Signal

TEST 203


0.27g/div
T→
50 mv/DIV
#8
to
tf

0.35g/div
#9
20 mv/DIV
to
tf


0.26g/div
50 mv/DIV
#10
to
tf


JSH ACCUCHART
#8
50mv/div
#9
20mv/div
TEST 203
50 mv/div
#10

FHWA/ENSCO IMPACT TEST FACILITY
TEST REQUEST

Test No. 204

Pole/Support 8WF20

Description of Setup: Slip base

Camera: Required yes [X] no [ ]

Film Color [X] B&W [ ]

Min. Speed 200

Max. Speed

Signals to be Recorded:

a. Accelerometers yes [X] no [ ]

b. Strain gauges yes [ ] no [X]

c. Speed transducers yes [X] no [ ]

d. Other None

Crush Characteristics:

Honeycomb #1 3/16" 130 psi 8"

#2 1/4" 230 psi 8"

#3 -

Initial Speed: 20 MPH

Mass (weight of pendulum mass): 2250 lbs.

Comments:

FHWA/ENSCO IMPACT TEST FACILITY

Test No. 204 Date: 10/8/74 Weather: Good

Personnel Present: RO, GK, JWA, KC

1. POWER

Circuit breakers on

1	[X]	2	[X]	3	[X]
4	[X]	8	[X]	10	[X]
11	[X]	13	[X]	14	[X]

2. RELEASE HOOK

Attached [X] Plugged In [X] Switch On [X]

3. ACCELEROMETERS

Mounted Correctly [X]

#1 Connected [X] 15 g's

#2 Connected [X] 50 g's

#3 Connected [X] 15 g's

Mounting Pattern of Pendulum Mass (Viewed from Rear)

[2]

[1] [3]

J-Box Connectors tightened [X]

J-Box Cable connected to Control Box [X]

#1 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

300 gain # 8 channel into Tape Recorder

#2 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

300 gain # 9 channel into Tape Recorder

#3 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

300 gain # 10 channel into Tape Recorder

4. SPEED TRANSDUCERS

Connected correctly to reference cell [X]

Connectors on reference cell correct [X]

Slots lined up [X]

Distance between first two 2 ft.

Distance between second two 2 ft.

Distance between sets 6.5 ft.

Connected correctly to control box [X]

Control box on [X]

Cable from RCDR to channel — on tape recorder

Cable from #1 to INPUTA on freq. counter [X]

Frequency counter turned on [X]

Sensitivity on [X]

#1 recorded on channel 2

#2 recorded on channel 3

5. CAMERA

PPS Dial 30 Mult Switch x10

Speed Reducer H Servo Brake L

Drag Brake 30 F Setting 4 Film ASA 80

Light meter reading - Film Color

Film correct [X] Prism correct [X] Trip switch [X]

Camera on stop [X] Timing light on [X] 100 pulses/sec

Balanced [X] Remote cable on [X] Power cable on [X]

Focus setting -

View portal correct [X]

6. CRUSH CHARACTERISTICS

Honeycomb: #1 3/16" 130 psi

#2 1/4" 230 psi

#3 -

7. POLE Type: 8WF20

Set up [X] Torqued exactly [X] Torque ≈ 100 ft-lbs.

8. TIMING LINES

Frequency 1 khz Voltage (peak to peak) 10 volts

Recorded on channel 1 input to tape recorder

9. TAPE RECORDER Tape # 001

Speed 60 ips

Start of calibration 200

End of calibration 242 Meter Setting

Start of Test 242

Calibration signals recorded [X]

10. MASS

Weight 2250 lbs.

Correct height [X] Est. initial velocity 20 mph

Accelerometer cables out of danger [X]

11. LAST SECOND ITEMS

Arm control box [X]

Reset frequency counter [X]

Initial # of Pulses (vis)	1347
Initial # of Pulses (rec)	1062
Final # of Pulses (rec)	1347
Impact meter reading	175
Final meter reading	192
Correction factor for height	.93
Amount of crush	7.5"

Remarks:

TEST # 204

DATA REDUCTION
FHWA/ENSCO IMPACT TEST FACILITY

1. Speed Transducers

A) Initial pulses 1062 → 29.43 fps = 20.06 mph

B) Final pulses 1347 :Cor. Factor .925 → 25.08 fps = 17.1 mph

Weight of mass = 2250 lbs.

ΔMV = (weight /32.2) x (a-b) lb-sec

= 304 lb-sec

2. Accelerometers

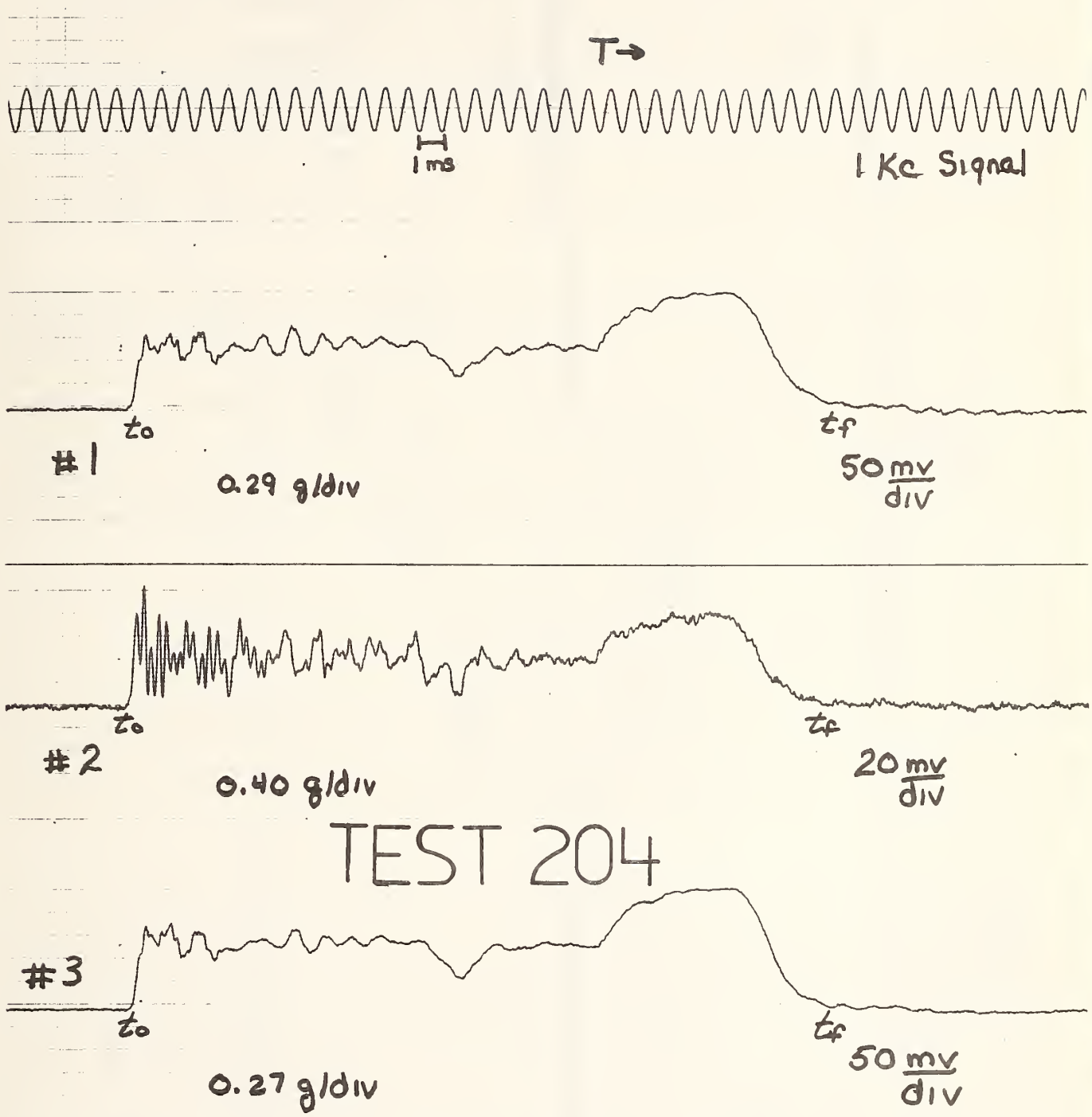
	Area	St. Area	Div.	Cal. Div.	Cal. g's	$\frac{1}{\Delta t}\int_0^{\Delta t} gdt$	Δt	$W\int_0^{\Delta t} gdt$
	2.175	3.84						
#1	2.145	3.75	25	15	4.34	4.11	31.0	287
	2.160	3.80						
	1.62	3.675						
#2	1.785	3.88	26	18	7.20	4.65	30	314
	1.70	3.78						
	2.28	3.795						
#3	2.46	3.90	26	24	6.41	4.27	30	288
	2.37	3.85						

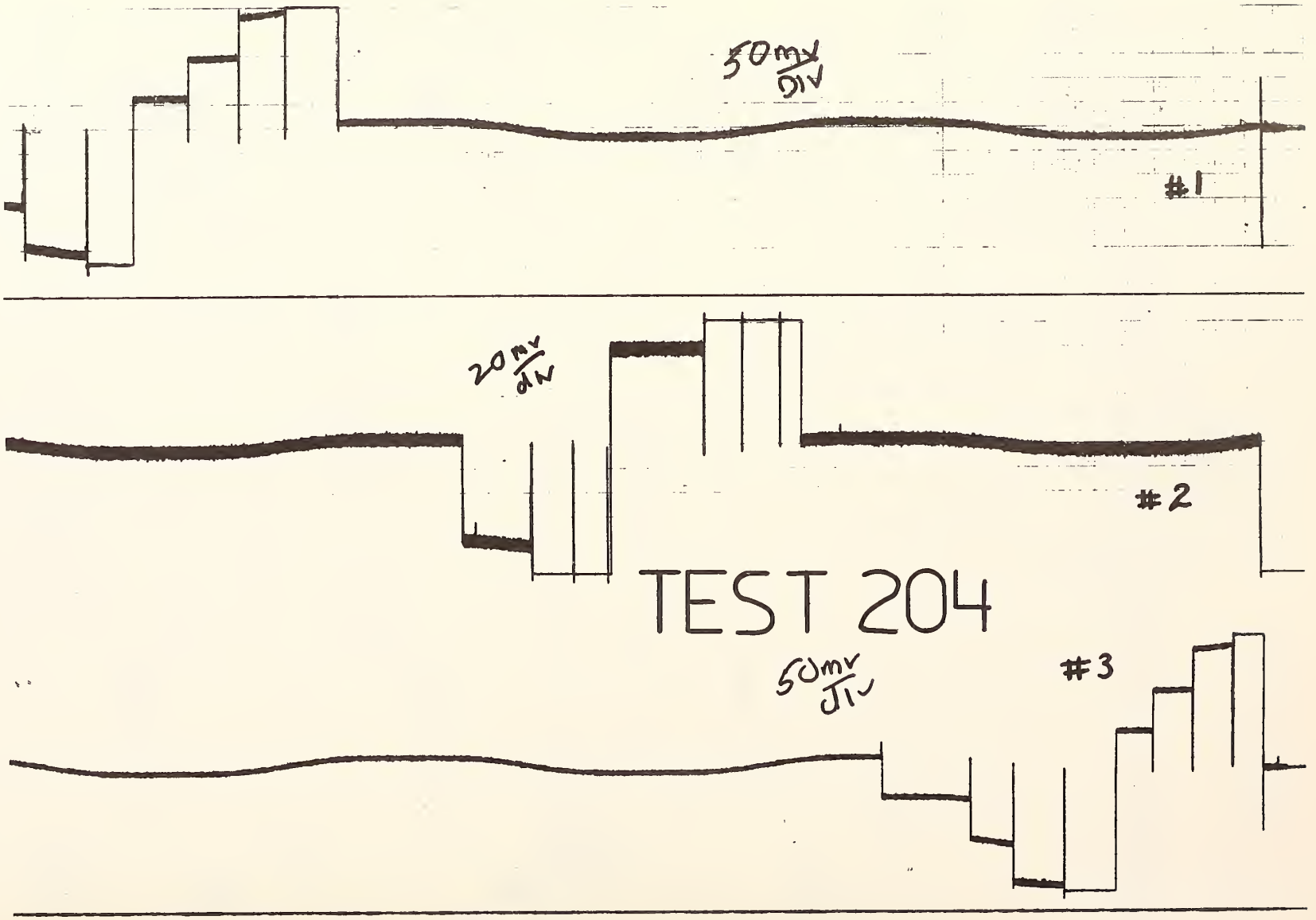
$$\frac{1}{\Delta t}\int_0^{\Delta t} gdt = \frac{\text{Area}}{\text{St. Area}} * \text{Div.} * \frac{\text{Cal. g's}}{\text{Cal. Div.}}$$

$M\Delta V = 298$ lb-sec

$$M\Delta V = W\int_0^{\Delta t} gdt$$

DATE 10/8/74 JWA


T→
1 ms
1 Kc Signal
t_o
t_f
#1
0.29 g/div
50 mv/div
t_o
t_f
#2
0.40 g/div
20 mv/div
TEST 204
#3
t_o
t_f
0.27 g/div
50 mv/div


50mv/DIV
#1
20mv/DIV
#2
TEST 204
50mv/DIV
#3

APPENDIX D

TEST DATA FOR DUAL LEGGED SIGN SUPPORTS
(8WF20) WITH SLIP BASES STRUCK BY RIGID PENDULUM

FHWA/ENSCO IMPACT TEST FACILITY
TEST REQUEST

Test No. 301

Pole/Support _____

Description of Setup: No force on base

_____

_____

_____

Camera: Required yes [ ] no [X]

Film Color [ ] B&W [X]

Min. Speed _____

Max. Speed _____

Signals to be Recorded:

a. Accelerometers yes [X] no [ ]

b. Strain gauges yes [ ] no [X]

c. Speed transducers yes [ ] no [X]

d. Other _____

Crush Characteristics:

Honeycomb #1 Rigid face

#2 _____

#3 _____

Initial Speed: 20 mph

Mass (weight of pendulum mass): 2250 lbs.

Comments: _____

FHWA/ENSCO IMPACT TEST FACILITY

Test No. 301 Date: 3/21/75 Weather: Clear

Personnel Present: JWA, RPO, TY

1. POWER

Circuit breakers on

1	[X]	2	[X]	3	[X]
4	[X]	8	[X]	10	[X]
11	[X]	13	[X]	14	[X]

2. RELEASE HOOK

Attached [X] Plugged In [X] Switch On [X]

3. ACCELEROMETERS

Mounted Correctly [X]

#1 Connected [X] 15 g's

#2 Connected [X] 50 g's

#3 Connected [X] 15 g's

Mounting Pattern of Pendulum Mass (Viewed from Rear)

[2]

[1] [3]

J-Box Connectors tightened [X]

J-Box Cable connected to Control Box [X]

#1 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

300 gain # 8 channel into Tape Recorder

#2 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

300 gain # 9 channel into Tape Recorder

#3 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

300 gain # 10 channel into Tape Recorder

4. SPEED TRANSDUCERS

Connected correctly to reference cell [X]

Connectors on reference cell correct [X]

Slots lined up [X]

Distance between first two 2 ft.

Distance between second two 2 ft.

Distance between sets 0.5/8.5 ft.

Connected correctly to control box [X]

Control box on [X]

Cable from RCDR to channel - on tape recorder

Cable from #1 to INPUTA on freq. counter [X]

Frequency counter turned on [X]

Sensitivity on [X]

#1 recorded on channel 2

#2 recorded on channel 3

5. CAMERA NOT USED

PPS Dial _____ Mult Switch _____

Speed Reducer _____ Servo Brake _____

Drag Brake _____ F Setting _____ Film ASA _____

Light meter reading _____ Film _____

Film correct ☐ Prism correct ☐ Trip switch ☐

Camera on stop ☐ Timing light on ☐ _____pulses/sec

Balanced ☐ Remote cable on ☐ Power cable on ☐

Focus setting _____

View portal correct ☐

6. CRUSH CHARACTERISTICS

Honeycomb: #1 None

#2 _____

#3 _____

7. POLE Type: 8WF20

Set up [X] Torqued exactly [X] Torque ≈ 0 ft-lbs.

8. TIMING LINES

Frequency 1 khz Voltage (peak to peak) 10 volts

Recorded on channel #1 input to tape recorder

9. TAPE RECORDER Tape # 001A

Speed 60 ips

Start of calibration 000

End of calibration 041] Meter Setting

Start of Test 042

Calibration signals recorded [X]

10. MASS

Weight 2250 lbs.

Correct height [X] Est. initial velocity 20 mph

Accelerometer cables out of danger [X]

11. LAST SECOND ITEMS

Arm control box [X]

Reset frequency counter [X]

Initial # of Pulses (vis)	227
Initial # of Pulses (rec)	1020?
Final # of Pulses (rec)	1054?
Impact meter reading	59
Final meter reading	66
Correction factor for height	99.5 %
Amount of crush	-

Remarks:

Gain too high on #8 and #10
Data good on #9
Arm not in center
Correction factor needed for both 1.148-1.178

TEST # 301

DATA REDUCTION
FHWA/ENSCO IMPACT TEST FACILITY

1. Speed Transducers (NOT USED)

A) Initial pulses _____ → _____ fps = _____ mph

B) Final pulses _____ :Cor. Factor _____ → _____ fps = _____ mph

Weight of mass = _____ lbs.

ΔMV = (weight /32.2) x (a-b) lb-sec

= _____ lb-sec

2. Accelerometers

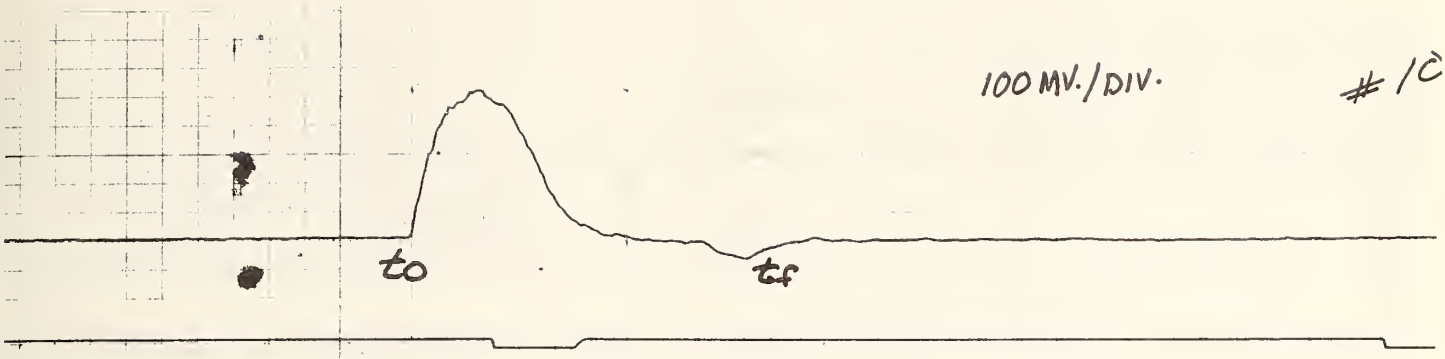
	Area	St. Area	Div.	Cal. Div.	Cal. g's	$\frac{1}{\Delta t}\int_0^{\Delta t} gdt$	Δt	$W\int_0^{\Delta t} gdt$
#1			Limited	22	8.64	-	-	-
#2	038 037 037	076 072 075	29	15.5	7.2	6.64	7.6/1000	114
#3			Limited	22.8	8.52	-	-	-

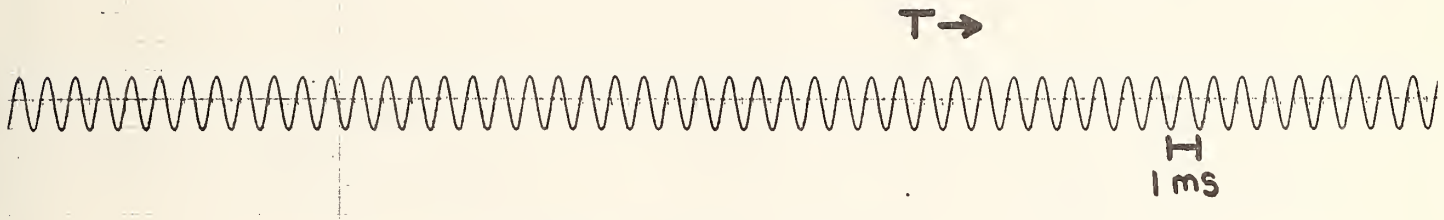
$$\frac{1}{\Delta t}\int_0^{\Delta t} gdt = \frac{\text{Area}}{\text{St. Area}} * \text{Div.} * \frac{\text{Cal. g's}}{\text{Cal. Div.}}$$

$$M\Delta V = W\int_0^{\Delta t} gdt$$

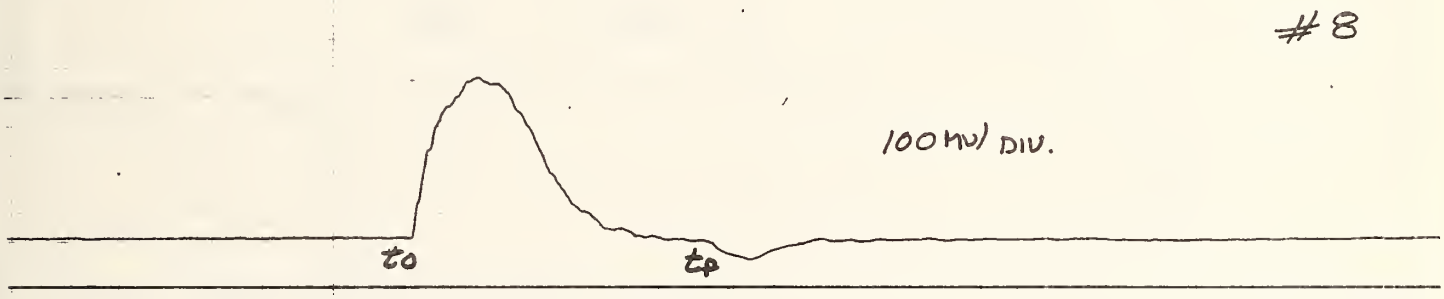
$M\Delta V$ = 114 lb-Sec

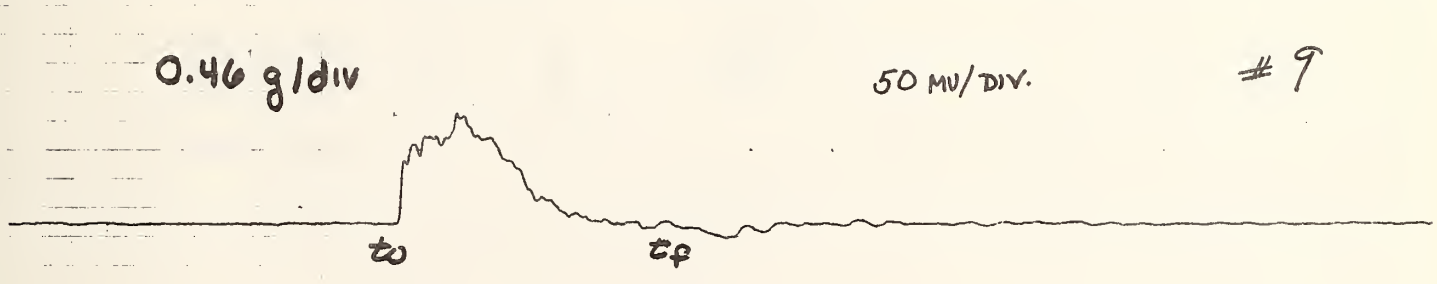
DATE 3/21/75 JWA

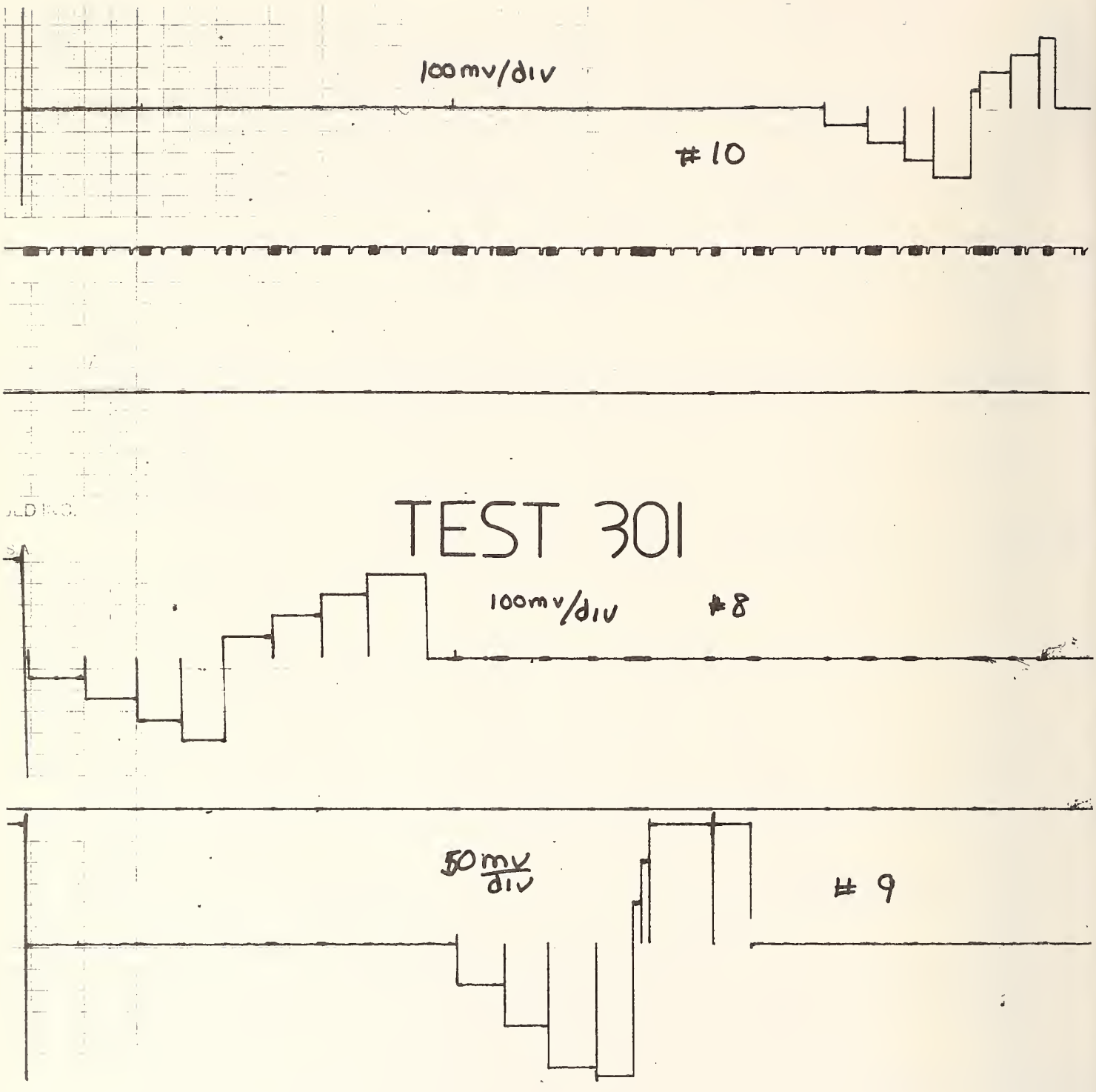

100 MV./DIV.
#1C
to
tf


T→
1 ms

TEST 301


#8
100 MV/ DIV.
to
tp


0.46 g/div
50 MV/DIV.
#9
to
tp


100mv/div
#10
TEST 301
100mv/div
#8
50 mv/div
#9

FHWA/ENSCO IMPACT TEST FACILITY
TEST REQUEST

Test No. 302

Pole/Support 8WF20 (8')

Description of Setup: Rigid Face Pendulum

Camera: Required yes [ ] no [X]

Film Color [-] B&W [-]

Min. Speed _____

Max. Speed _____

Signals to be Recorded:

a. Accelerometers yes [X] no [ ]

b. Strain gauges yes [ ] no [X]

c. Speed transducers yes [X] no [ ]

d. Other _____

Crush Characteristics:

Honeycomb #1 N/A

#2 Rigid Face

#3

Initial Speed: 20 MPH

Mass (weight of pendulum mass): 2250 lbs.

Comments:

FHWA/ENSCO IMPACT TEST FACILITY

Test No. 302 Date: 3/21/75 Weather: Good

Personnel Present: JA, RO, TY

1. POWER

Circuit breakers on

1	[X]	2	[X]	3	[X]
4	[X]	8	[X]	10	[X]
11	[X]	13	[X]	14	[X]

2. RELEASE HOOK

Attached [X] Plugged In [X] Switch On [X]

3. ACCELEROMETERS

Mounted Correctly [X]

#1 Connected [X] 15 g's

#2 Connected [X] 50 g's

#3 Connected [X] 15 g's

Mounting Pattern of Pendulum Mass (Viewed from Rear)

[2]

[1] [3]

J-Box Connectors tightened [X]

J-Box Cable connected to Control Box [X]

#1 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

100 gain # 8 channel into Tape Recorder

#2 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

300 gain # 9 channel into Tape Recorder

#3 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

100 gain # 10 channel into Tape Recorder

4. SPEED TRANSDUCERS

Connected correctly to reference cell [X]

Connectors on reference cell correct [X]

Slots lined up [X]

Distance between first two 2 ft.

Distance between second two 2 ft.

Distance between sets 5'3" ft.

Connected correctly to control box [X]

Control box on [X]

Cable from RCDR to channel — on tape recorder

Cable from #1 to INPUTA on freq. counter [X]

Frequency counter turned on [X]

Sensitivity on [X]

#1 recorded on channel 2

#2 recorded on channel 3

5. CAMERA (N/A)

PPS Dial _____ Mult Switch _____

Speed Reducer _____ Servo Brake _____

Drag Brake _____ F Setting _____ Film ASA _____

Light meter reading _____ Film _____

Film correct ☐ Prism correct ☐ Trip switch ☐

Camera on stop ☐ Timing light on ☐ _____pulses/sec

Balanced ☐ Remote cable on ☐ Power cable on ☐

Focus setting _____

View portal correct ☐

6. CRUSH CHARACTERISTICS (N/A)

Honeycomb: #1 _____

#2 _____

#3 _____

7. POLE Type: 8WF20 (8 feet)

Set up [X] Torqued exactly [X] Torque ≈0 ft-lbs.

8. TIMING LINES

Frequency 1000 hz Voltage (peak to peak) 10 volts

Recorded on channel 1 input to tape recorder

9. TAPE RECORDER Tape # 001-A

Speed .60 ips

Start of calibration 100

End of calibration 130 Meter Setting

Start of Test 130

Calibration signals recorded [X]

10. MASS

Weight 2250 lbs.

Correct height [X] Est. initial velocity 20 mph

Accelerometer cables out of danger [X]

11. LAST SECOND ITEMS

Arm control box [X]

Reset frequency counter [X]

Initial # of Pulses (vis)	1064
Initial # of Pulses (rec)	1063
Final # of Pulses (rec)	-
Impact meter reading	≈ 137
Final meter reading	140
Correction factor for height	-
Amount of crush	-

Remarks:

TEST # 302

DATA REDUCTION
FHWA/ENSCO IMPACT TEST FACILITY

1. Speed Transducers

A) Initial pulses 1063 → _____ fps = ___ mph

B) Final pulses _____ :Cor. Factor _____ → _____ fps = ___ mph

Weight of mass = 2250 lbs.

ΔMV = (weight /32.2) x (a-b) lb-sec

= ___ lb-sec

2. Accelerometers

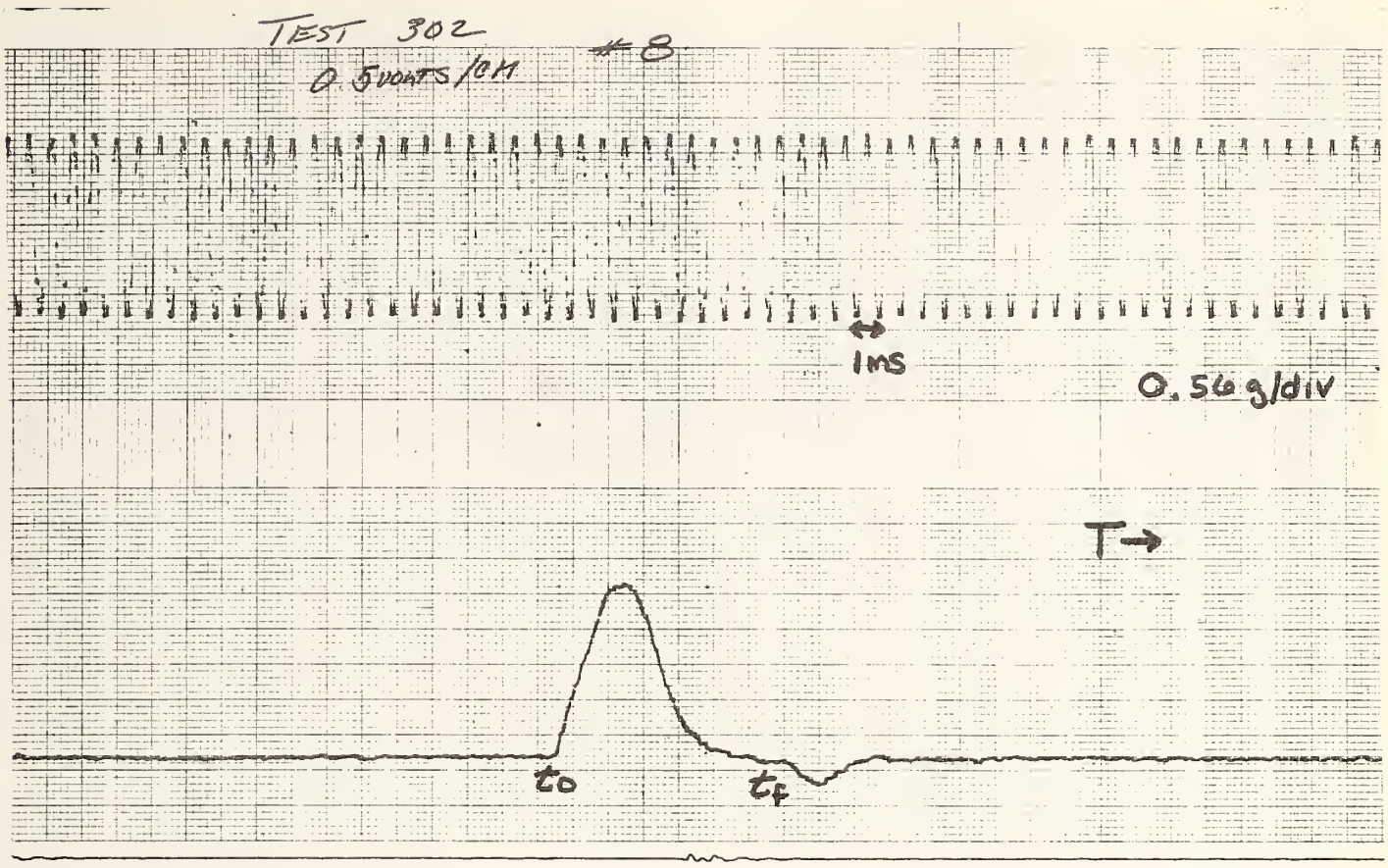
	Area	St. Area	Div.	Cal. Div.	Cal. g's	$\frac{1}{\Delta t}\int_0^{\Delta t} gdt$	Δt	$W\int_0^{\Delta t} gdt$
	034	053						
#1	032	055	24	15.5	8.64	8.17	7/1000	129
	033	054						
	26	56						
#2	28	56	22	12	7.2	6.36	7/1000	100
	27	56						
	034	063						
#3	032	062	26	15.5	8.52	7.55	7/1000	119
	033	0625						

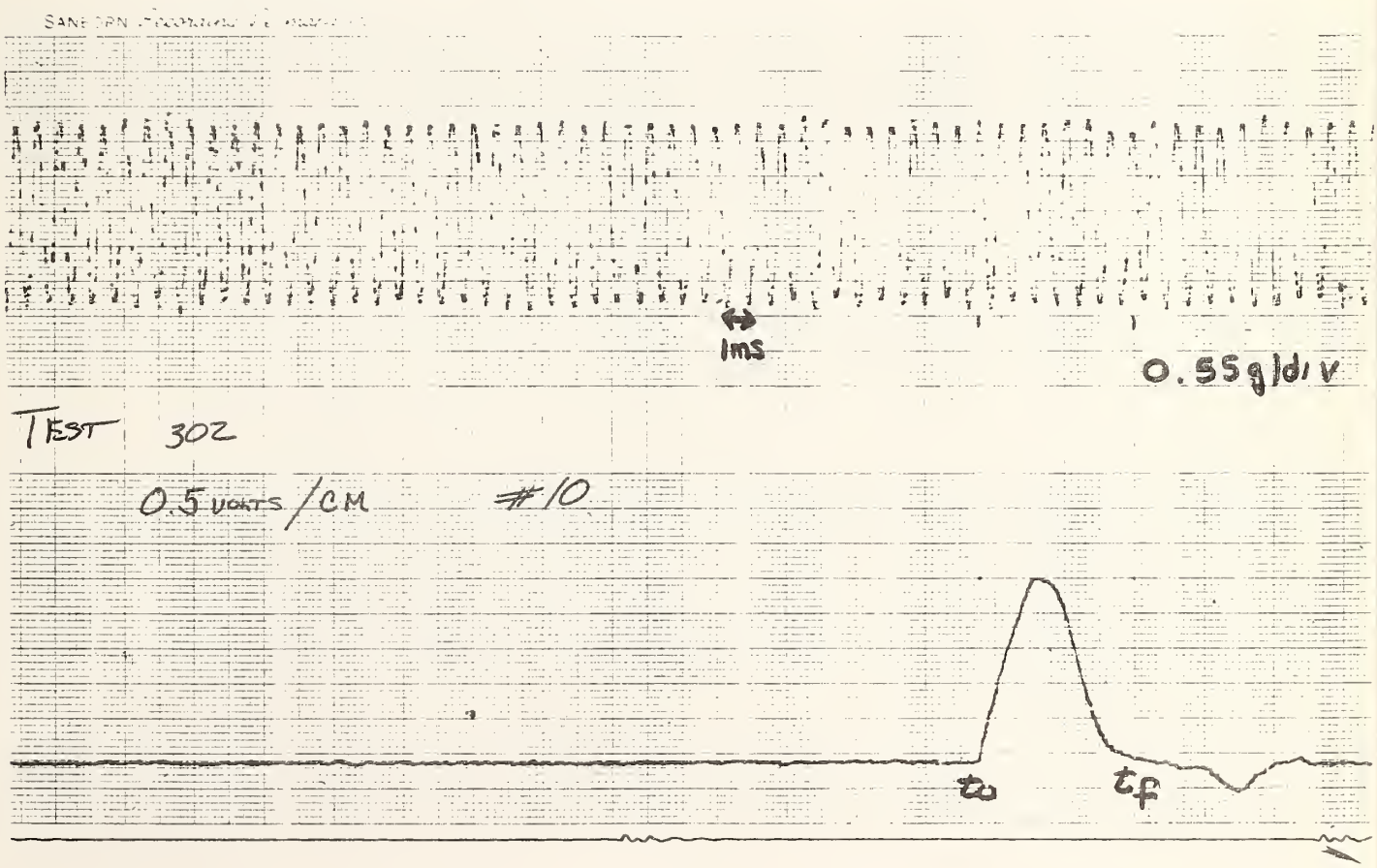
$$\frac{1}{\Delta t}\int_0^{\Delta t} gdt = \frac{\text{Area}}{\text{St. Area}} * \text{Div.} * \frac{\text{Cal. g's}}{\text{Cal. Div.}}$$

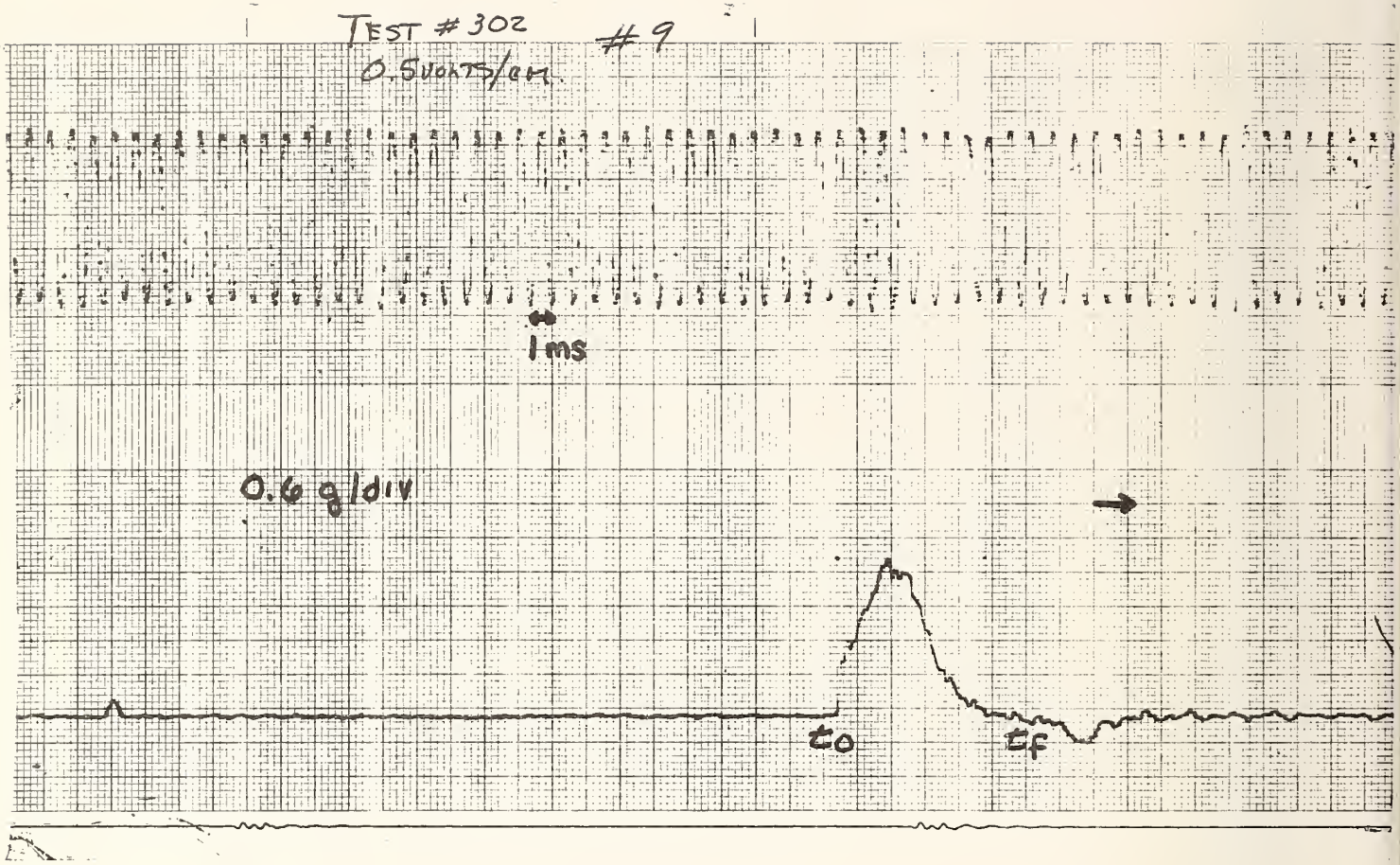
$$M\Delta V = W\int_0^{\Delta t} gdt$$

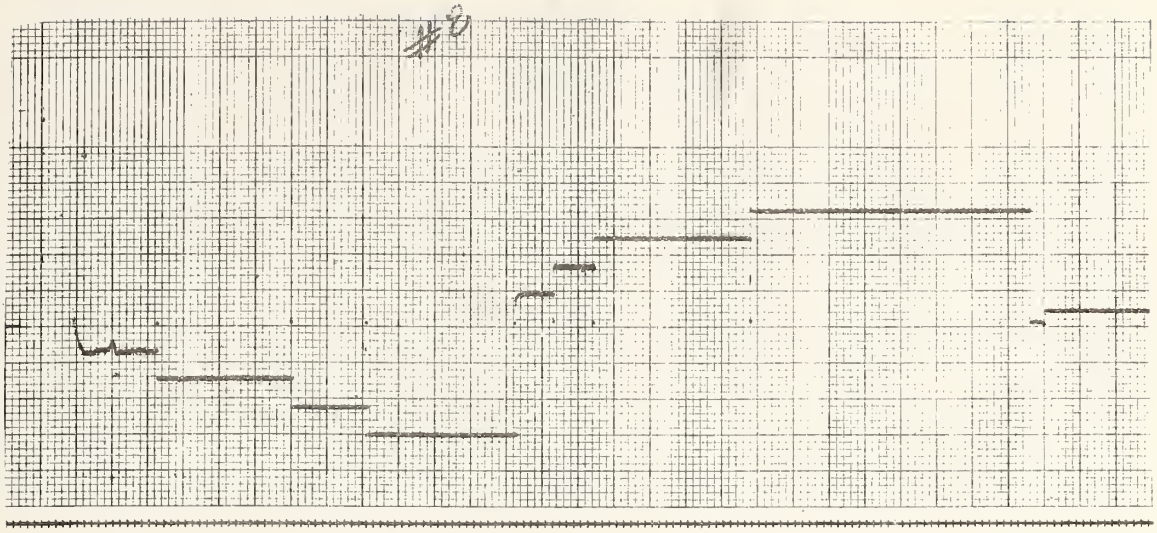
$M\Delta V$ = 116 lb-sec ± 8

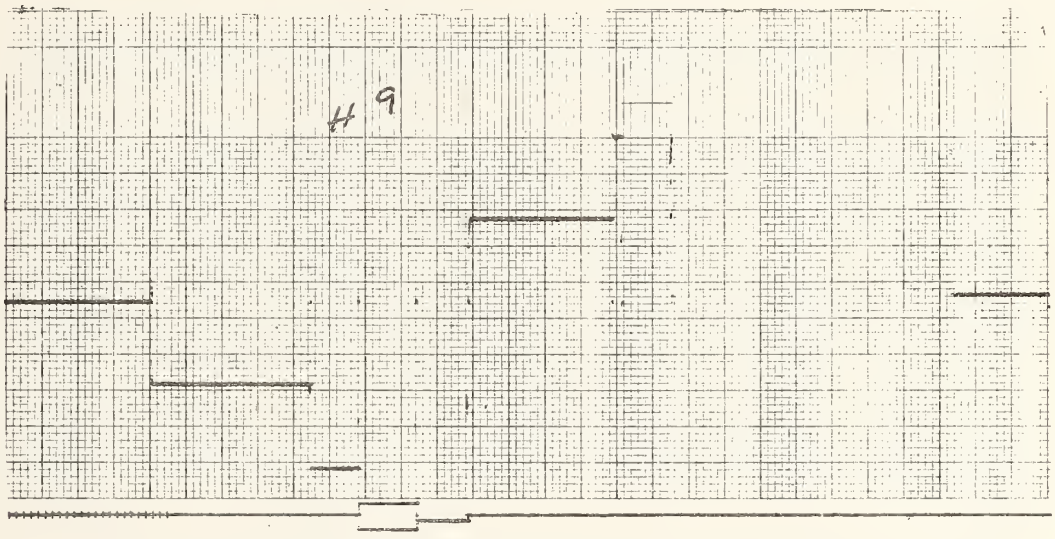
DATE 3/24/75 JWA

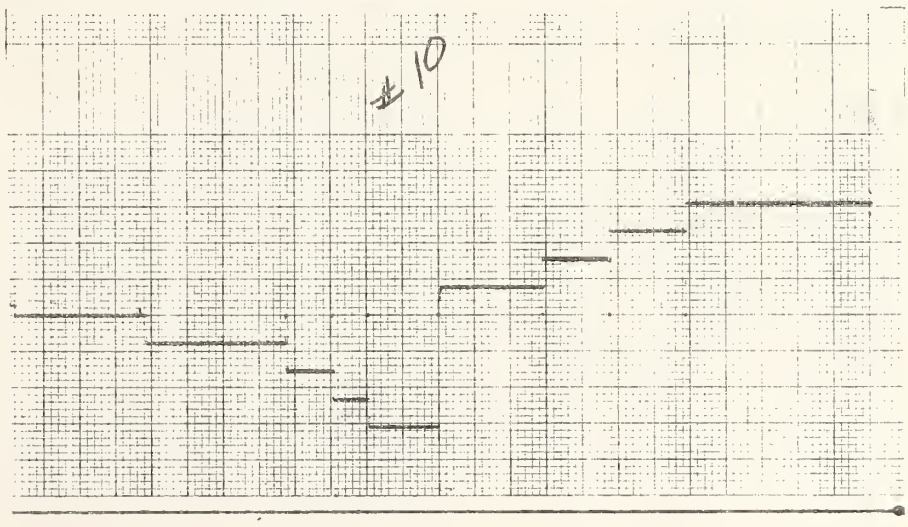

TEST 302
0.5 VOLTS/CM
#8
1ms
0.56 g/div
T→
t_o
t_f


1ms
0.55 g/div
TEST 302
0.5 VOLTS/CM
#10
t_o
t_f


TEST #302 #9
0.5 VOLTS/cm.
1ms
0.6 g/div
t_0
t_f







CALIBRATION SIGNAL - 302 .4V/CM

FHWA/ENSCO IMPACT TEST FACILITY
TEST REQUEST

Test No. 303

Pole/Support 8' - 8WF20

Description of Setup: No torque on bolts - rigid face

Camera: Required yes [ ] no [X]

Film Color [ ] B&W [ ]

Min. Speed _____

Max. Speed _____

Signals to be Recorded:

a. Accelerometers yes [X] no [ ]

b. Strain gauges yes [ ] no [X]

c. Speed transducers yes [ ] no [X]

d. Other None

Crush Characteristics:

Honeycomb #1 N/A

#2 _____

#3 _____

Initial Speed: 20 MPH

Mass (weight of pendulum mass): 2250 lbs.

Comments: _____

FHWA/ENSCO IMPACT TEST FACILITY

Test No. 303 Date: 3/27/75 Weather: Good

Personnel Present: JWA, RO

1. POWER

Circuit breakers on

1	[X]	2	[X]	3	[X]
4	[X]	8	[X]	10	[X]
11	[X]	13	[X]	14	[X]

2. RELEASE HOOK

Attached [X] Plugged In [X] Switch On [X]

3. ACCELEROMETERS

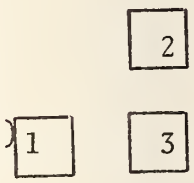
Mounted Correctly [X]

#1 Connected [X] 15 g's

#2 Connected [X] 50 g's

#3 Connected [X] 15 g's

Mounting Pattern of Pendulum Mass (Viewed from Rear)



J-Box Connectors tightened [X]

J-Box Cable connected to Control Box [X]

#1 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

100 gain # 8 channel into Tape Recorder

#2 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

300 gain # 9 channel into Tape Recorder

#3 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

100 gain # 10 channel into Tape Recorder

4. SPEED TRANSDUCERS (N/A)

Connected correctly to reference cell [ ]

Connectors on reference cell correct [ ]

Slots lined up [ ]

Distance between first two _____ ft.

Distance between second two _____ ft.

Distance between sets _____ ft.

Connected correctly to control box [ ]

Control box on [ ]

Cable from RCDR to channel _____ on tape recorder

Cable from #1 to INPUTA on freq. counter [ ]

Frequency counter turned on [ ]

Sensitivity on [ ]

#1 recorded on channel _____

#2 recorded on channel _____

5. CAMERA (N/A)

PPS Dial _____ Mult Switch _____

Speed Reducer _____ Servo Brake _____

Drag Brake _____ F Setting _____ Film ASA _____

Light meter reading _____ Film _____

Film correct ☐ Prism correct ☐ Trip switch ☐

Camera on stop ☐ Timing light on ☐ _____pulses/sec

Balanced ☐ Remote cable on ☐ Power cable on ☐

Focus setting _____

View portal correct ☐

6. CRUSH CHARACTERISTICS (N/A)

Honeycomb: #1 _____

#2 _____

#3 Rigid Face _____

7. POLE Type: 8WF20

Set up [X] Torqued exactly [-] Torque ~0 ft-lbs.

8. TIMING LINES

Frequency 1 khz Voltage (peak to peak) 10 volts

Recorded on channel 1 input to tape recorder

9. TAPE RECORDER Tape # 001A

Speed 60 ips

Start of calibration 210

End of calibration 245 } Meter Setting

Start of Test 245

Calibration signals recorded [X]

10. MASS

Weight 2250 lbs.

Correct height [X] Est. initial velocity 20 mph

Accelerometer cables out of danger [X]

11. LAST SECOND ITEMS

Arm control box ☐ N/A

Reset frequency counter ☐

Initial # of Pulses (vis) _____

Initial # of Pulses (rec) _____

Final # of Pulses (rec) _____

Impact meter reading _____

Final meter reading _____

Correction factor for height _____

Amount of crush _____

Remarks:

TEST # 303

DATA REDUCTION
FHWA/ENSCO IMPACT TEST FACILITY

1. Speed Transducers (N/A)

A) Initial pulses _____ → _____ fps = _____ mph

B) Final pulses _____ :Cor. Factor _____ → _____ fps = _____ mph

Weight of mass = _____ lbs.

ΔMV = (weight /32.2) x (a-b) lb-sec

= _____ lb-sec

2. Accelerometers

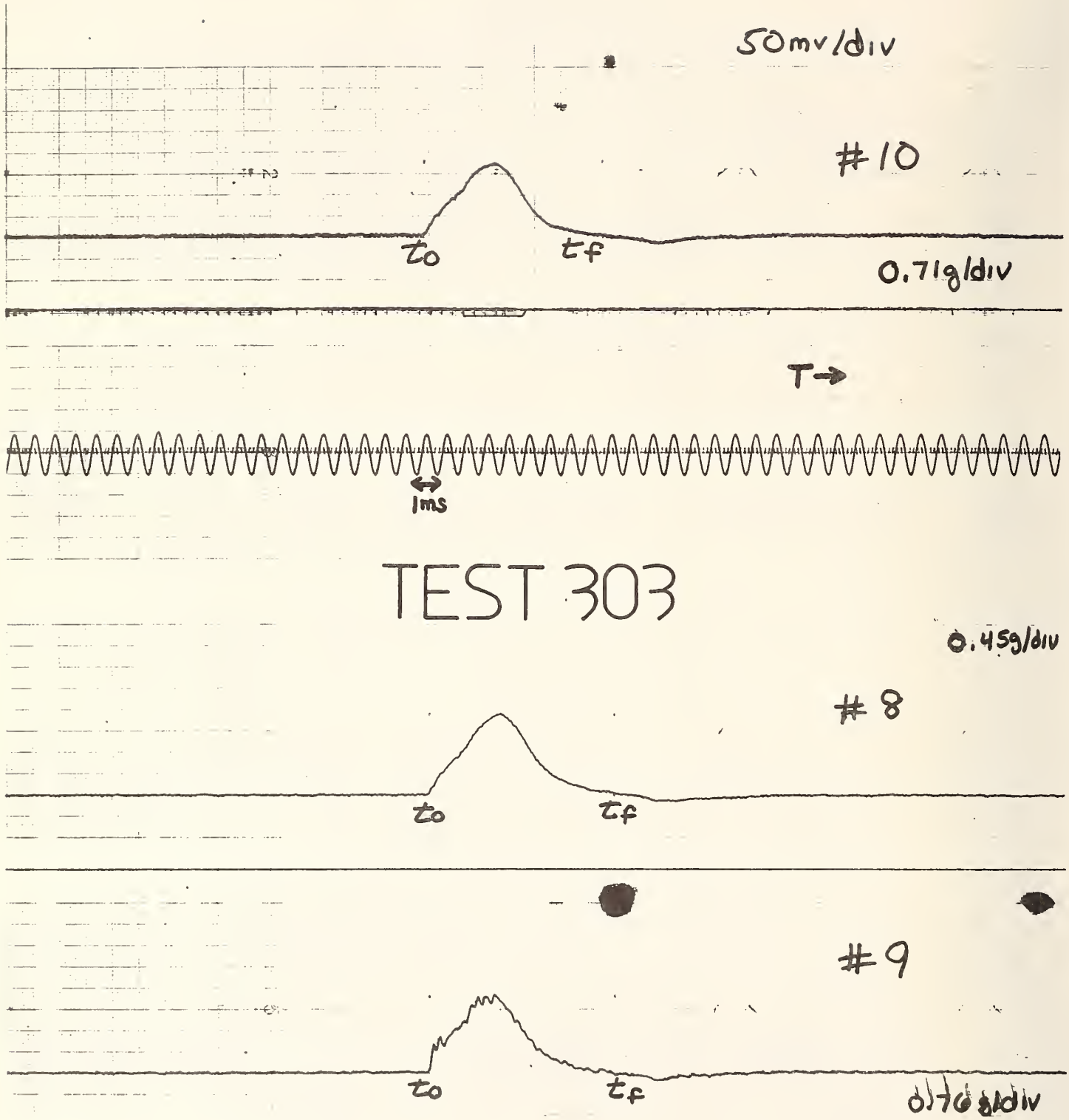
	Area	St. Area	Div.	Cal. Div.	Cal. g's	$\frac{1}{\Delta t}\int_0^{\Delta t} gdt$	Δt	$W\int_0^{\Delta t} gdt$
	25	50						
#1	29	57	19	13	8.64	6.0	9	121
	27	57						
	22	55						
#2	24	58	18	19	14.46	5.58	9	113
	23	56.5						
	25	53						
#3	25	52	18	12	8.52	6.1	8.9	123
	25	52						

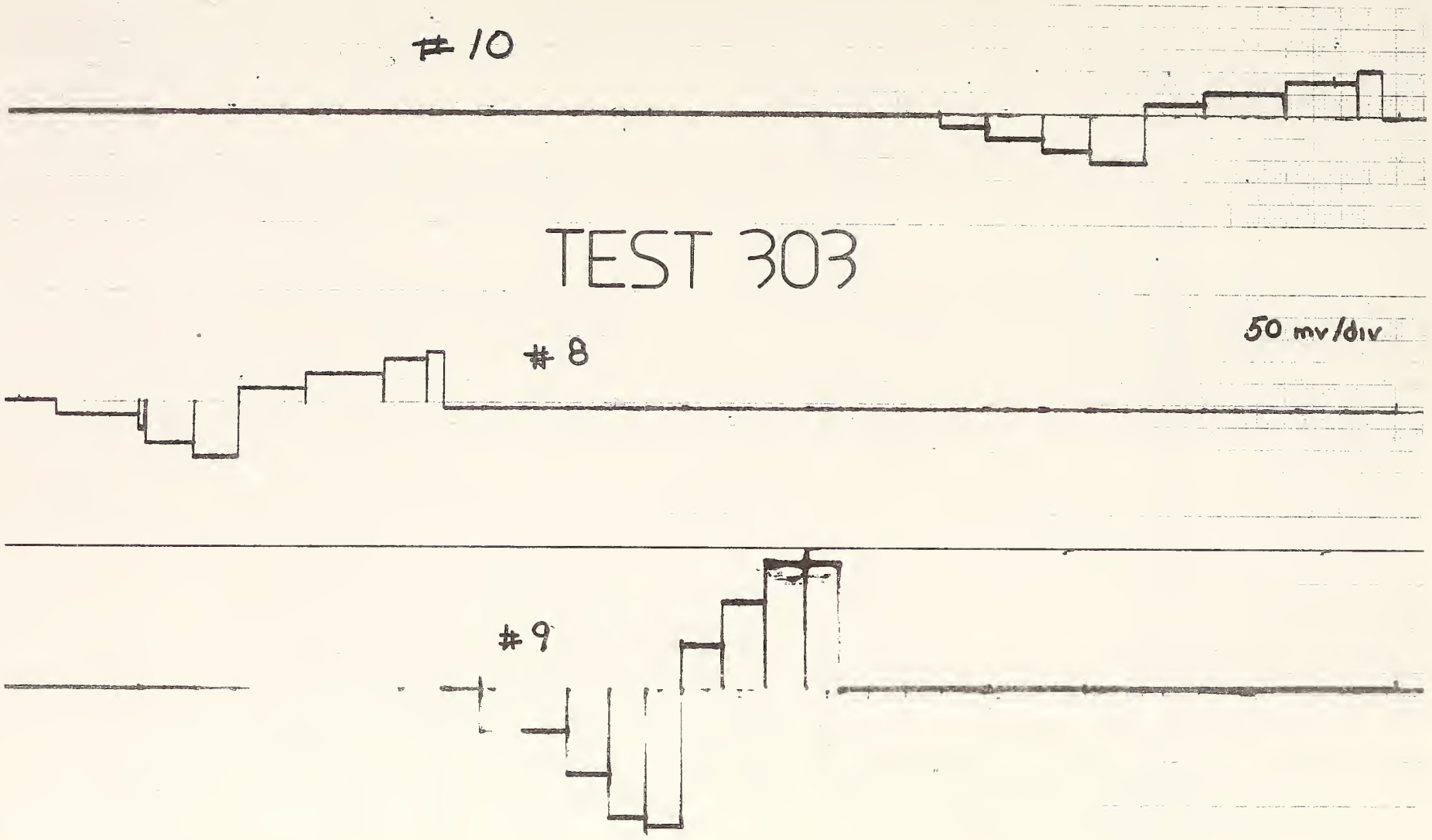
$$\frac{1}{\Delta t}\int_0^{\Delta t} gdt = \frac{\text{Area}}{\text{St. Area}} * \text{Div.} * \frac{\text{Cal. g's}}{\text{Cal. Div.}}$$

$M\Delta V$ =119 lb-sec

$$M\Delta V = W\int_0^{\Delta t} gdt$$

DATE 3/27/75 JWA


50mv/div
#10
to
tf
0.71g/div
T→
1mS
TEST 303
0.45g/div
#8
to
tf
#9
to
tf


#10
TEST 303
50 mv/div
#8
#9

FHWA/ENSCO IMPACT TEST FACILITY
TEST REQUEST

Test No. 304

Pole/Support 8WF20 16 feet section - rigid face

Description of Setup: _____

_____

_____

_____

Camera: Required yes [ ] no [X]

Film Color [ ] B&W [ ]

Min. Speed _____

Max. Speed _____

Signals to be Recorded:

a. Accelerometers yes [X] no [ ]

b. Strain gauges yes [ ] no [X]

c. Speed transducers yes [ ] no [X]

d. Other _____

Crush Characteristics: None

Honeycomb #1 –

#2

#3

Initial Speed: 20 MPH

Mass (weight of pendulum mass): 2250 lbs.

Comments:

FHWA/ENSCO IMPACT TEST FACILITY

Test No. 204 Date: 3/27/75 Weather: Cold

Personnel Present: JWA, RPO

1. POWER

Circuit breakers on

1	[X]	2	[X]	3	[X]
4	[X]	8	[X]	10	[X]
11	[X]	13	[X]	14	[X]

2. RELEASE HOOK

Attached [X] Plugged In [X] Switch On [X]

3. ACCELEROMETERS

Mounted Correctly [X]

#1 Connected [X] 15 g's

#2 Connected [X] 50 g's

#3 Connected [X] 15 g's

Mounting Pattern of Pendulum Mass (Viewed from Rear)

[2]

[1] [3]

J-Box Connectors tightened [X]

J-Box Cable connected to Control Box [X]

#1 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

100 gain # 8 channel into Tape Recorder

#2 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

300 gain # 9 channel into Tape Recorder

#3 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

100 gain # 10 channel into Tape Recorder

4. SPEED TRANSDUCERS (N/A)

Connected correctly to reference cell [ ]

Connectors on reference cell correct [ ]

Slots lined up [ ]

Distance between first two _____ ft.

Distance between second two _____ ft.

Distance between sets _____ ft.

Connected correctly to control box [ ]

Control box on [ ]

Cable from RCDR to channel _____ on tape recorder

Cable from #1 to INPUTA on freq. counter [ ]

Frequency counter turned on [ ]

Sensitivity on [ ]

#1 recorded on channel _____

#2 recorded on channel _____

5. CAMERA (N/A)

PPS Dial _____ Mult Switch _____

Speed Reducer _____ Servo Brake _____

Drag Brake _____ F Setting _____ Film ASA _____

Light meter reading _____ Film _____

Film correct ☐ Prism correct ☐ Trip switch ☐

Camera on stop ☐ Timing light on ☐ _____pulses/sec

Balanced ☐ Remote cable on ☐ Power cable on ☐

Focus setting _____

View portal correct ☐

6. CRUSH CHARACTERISTICS (N/A)

Honeycomb: #1 _____

#2 _____

#3 _____

7. POLE Type: 8WF20 - 16 feet - bolted

Set up [X] Torqued exactly [X] Torque 0 ft-lbs.

8. TIMING LINES

Frequency 1 khz Voltage (peak to peak) 10 volts

Recorded on channel 1 input to tape recorder

9. TAPE RECORDER Tape # 001A

Speed 60 ips

Start of calibration 264

End of calibration 3 Meter Setting

Start of Test 310

Calibration signals recorded [X]

10. MASS

Weight 2250 lbs.

Correct height [X] Est. initial velocity 20 mph

Accelerometer cables out of danger [X]

11. LAST SECOND ITEMS

Arm control box [X]

Reset frequency counter [X]

Initial # of Pulses (vis)	-
Initial # of Pulses (rec)	-
Final # of Pulses (rec)	-
Impact.meter reading	-
Final meter reading	338
Correction factor for height	-
Amount of crush	-

Remarks:

TEST # 304

DATA REDUCTION
FHWA/ENSCO IMPACT TEST FACILITY

1. Speed Transducers (N/A)

A) Initial pulses _____ → _____ fps = _____ mph

B) Final pulses _____ :Cor. Factor _____ → _____ fps = _____ mph

Weight of mass = _____ lbs.

ΔMV = (weight /32.2) x (a-b) lb-sec

= _____ lb-sec

2. Accelerometers

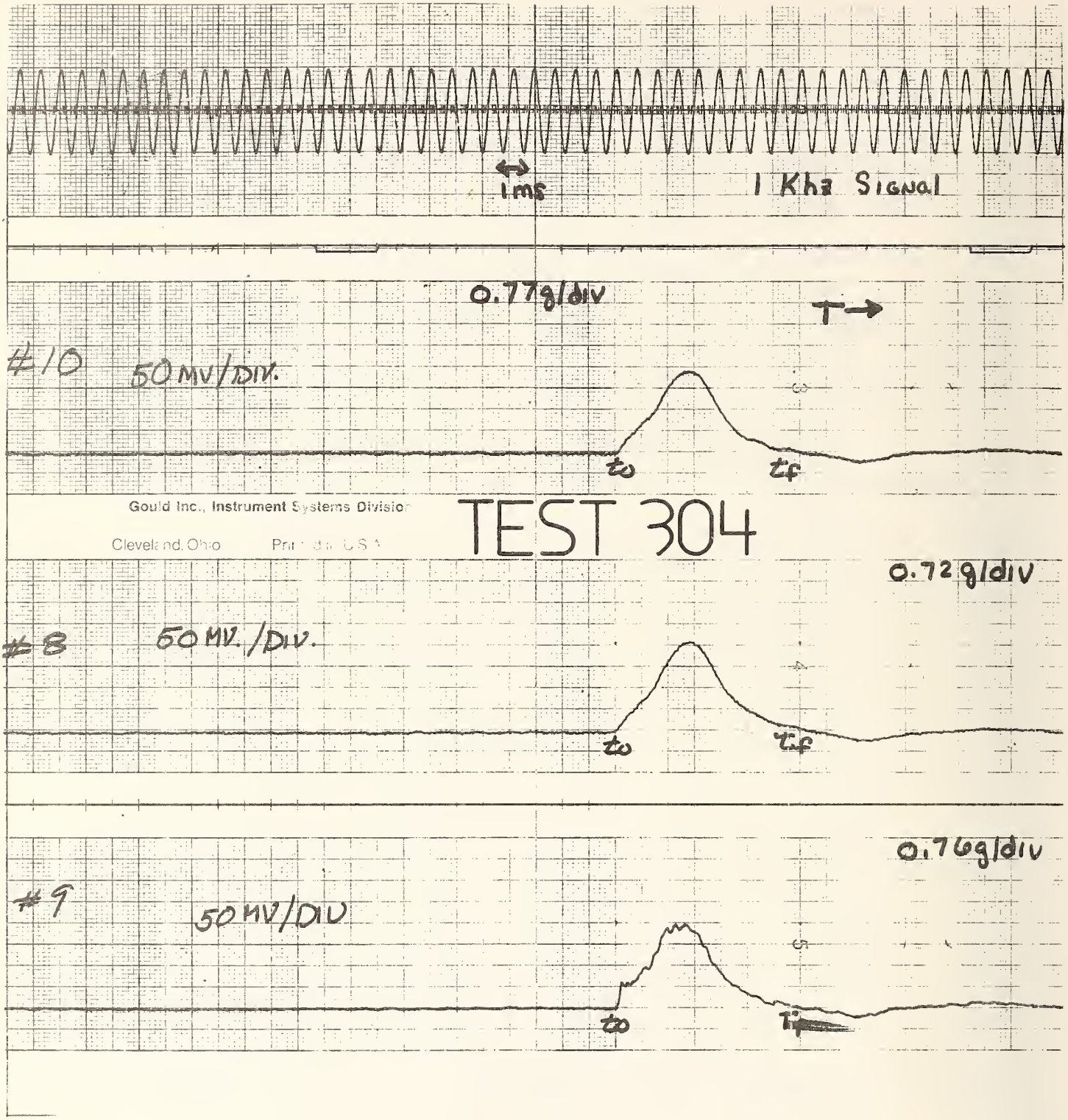
	Area	St. Area	Div.	Cal. Div.	Cal. g's	$\frac{1}{\Delta t}\int_0^{\Delta t} gdt$	Δt	$W\int_0^{\Delta t} gdt$
	28	58						
#1	28	60	21	12	8.64	7.17	8.9	144
	28	59						
	27	60						
#2	27	56	20	19	14.46	7.08	8.9	142
	27	58						
	25	60						
#3	28	58	19	11	8.52	6.7	8.9	135
	27	59						

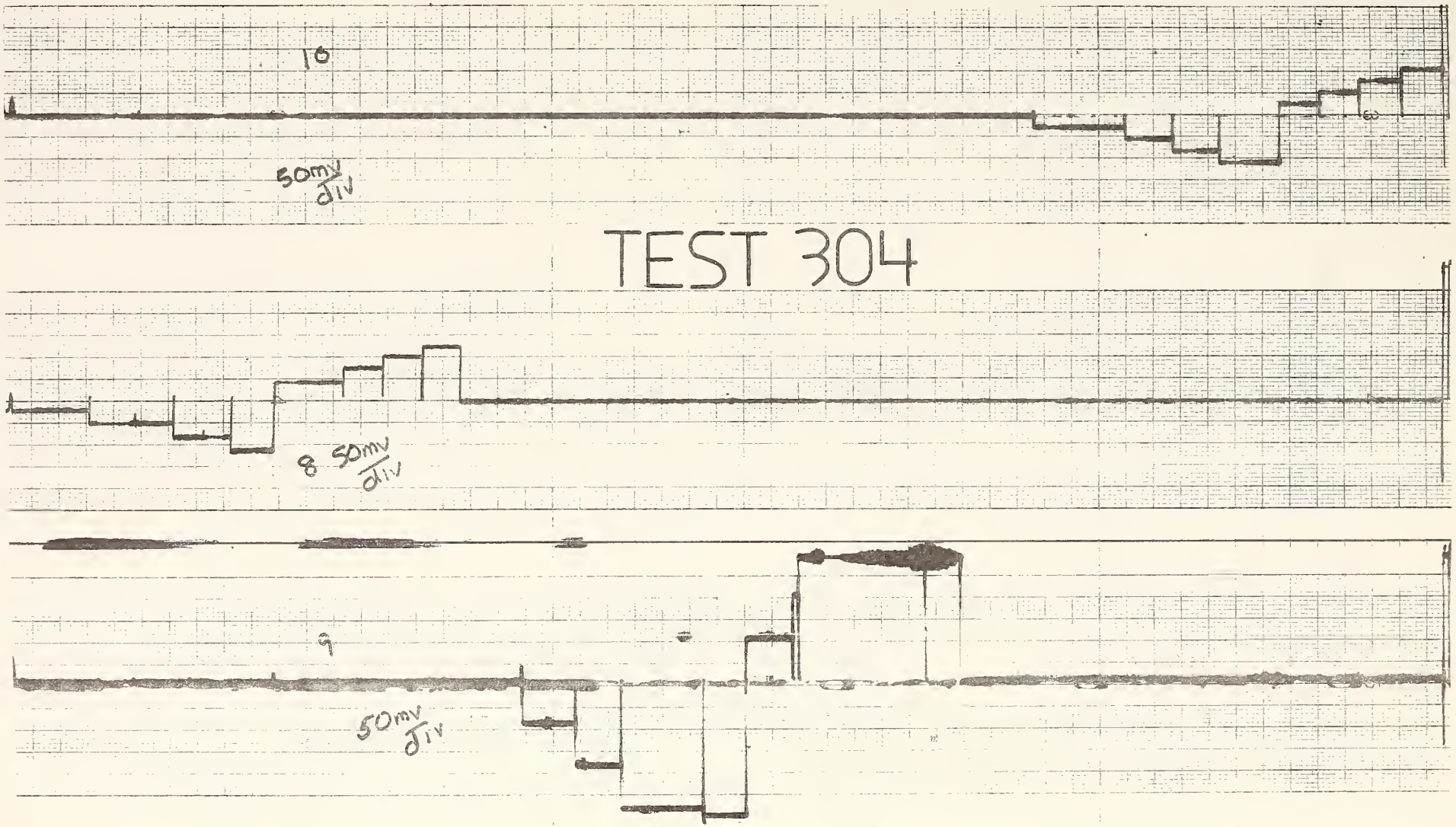
$$\frac{1}{\Delta t}\int_0^{\Delta t} gdt = \frac{\text{Area}}{\text{St. Area}} * \text{Div.} * \frac{\text{Cal. g's}}{\text{Cal. Div.}}$$

$$M\Delta V = W\int_0^{\Delta t} gdt$$

$M\Delta V$ = 140 lb-Sec

DATE 3/27/75 JWA


1ms
1 Khz Signal
0.77g/div
#10
50 MV/DIV.
to
tf
Gould Inc., Instrument Systems Division
Cleveland, Ohio
TEST 304
0.72g/div
#8
50 MV./DIV.
to
tf
0.76g/div
#9
50 MV/DIV
to
tf


10
50mv/div
TEST 304
8 50mv/div
9
50mv/div

FHWA/ENSCO IMPACT TEST FACILITY
TEST REQUEST

Test No. 305

Pole/Support 8WF20 - 8 feet

Description of Setup: Hi shear CHL bolts torqued to≈100 ft-lbs.

Camera: Required yes [ ] no [X]

Film Color [ ] B&W [ ]

Min. Speed _____

Max. Speed _____

Signals to be Recorded:

a. Accelerometers yes [X] no [ ]

b. Strain gauges yes [ ] no [X]

c. Speed transducers yes [ ] no [X]

d. Other None

Crush Characteristics: (N/A)

Honeycomb #1 _____

#2 _____

#3 _____

Initial Speed: 20 MPH

Mass (weight of pendulum mass): 2250 lbs.

Comments: _____

FHWA/ENSCO IMPACT TEST FACILITY

Test No. 305 Date: 3/27/75 Weather: Good

Personnel Present: JWA, RO

1. POWER

Circuit breakers on

1	[X]	2	[X]	3	[X]
4	[X]	8	[X]	10	[X]
11	[X]	13	[X]	14	[X]

2. RELEASE HOOK

Attached [X] Plugged In [X] Switch On [X]

3. ACCELEROMETERS

Mounted Correctly [X]

#1 Connected [X] 15 g's

#2 Connected [X] 50 g's

#3 Connected [X] 15 g's

Mounting Pattern of Pendulum Mass (Viewed from Rear)

[2]

[1] [3]

J-Box Connectors tightened [X]

J-Box Cable connected to Control Box [X]

#1 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

100 gain # 8 channel into Tape Recorder

#2 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

300 gain # 9 channel into Tape Recorder

#3 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

100 gain # 10 channel into Tape Recorder

4. SPEED TRANSDUCERS (N/A)

Connected correctly to reference cell [ ]

Connectors on reference cell correct [ ]

Slots lined up [ ]

Distance between first two _____ ft.

Distance between second two _____ ft.

Distance between sets _____ ft.

Connected correctly to control box [ ]

Control box on [ ]

Cable from RCDR to channel _____ on tape recorder

Cable from #1 to INPUTA on freq. counter [ ]

Frequency counter turned on [ ]

Sensitivity on [ ]

#1 recorded on channel _____

#2 recorded on channel _____

5. CAMERA (N/A)

PPS Dial _____ Mult Switch _____

Speed Reducer _____ Servo Brake _____

Drag Brake _____ F Setting _____ Film ASA _____

Light meter reading _____ Film _____

Film correct ☐ Prism correct ☐ Trip switch ☐

Camera on stop ☐ Timing light on ☐ _____pulses/sec

Balanced ☐ Remote cable on ☐ Power cable on ☐

Focus setting _____

View portal correct ☐

6. CRUSH CHARACTERISTICS (N/A)

Honeycomb: #1 _____

#2 _____

#3 _____

7. POLE Type: 8WF20 - 8 feet

Set up [X] Torqued exactly [X] Torque Hi shear ft-lbs.

8. TIMING LINES

Frequency 1000 hz Voltage (peak to peak) 10 volts

Recorded on channel 1 input to tape recorder

9. TAPE RECORDER Tape # 001-A

Speed 60 ips

Start of calibration 350

End of calibration 382] Meter Setting

Start of Test 382

Calibration signals recorded [X]

10. MASS

Weight 2250 lbs.

Correct height [X] Est. initial velocity 20 mph

Accelerometer cables out of danger [X]

11. LAST SECOND ITEMS

Arm control box ☐ N/A

Reset frequency counter ☐ N/A

Initial # of Pulses (vis)	-
Initial # of Pulses (rec)	-
Final # of Pulses (rec)	-
Impact meter reading	-
Final meter reading	398
Correction factor for height	-
Amount of crush	-

Remarks:

TEST # 305

DATA REDUCTION
FHWA/ENSCO IMPACT TEST FACILITY

1. Speed Transducers (N/A)

A) Initial pulses _____ → _____ fps = _____ mph

B) Final pulses _____ :Cor. Factor _____ → _____ fps = _____ mph

Weight of mass = _____ lbs.

ΔMV = (weight /32.2) x (a-b) lb-sec

= _____ lb-sec

2. Accelerometers

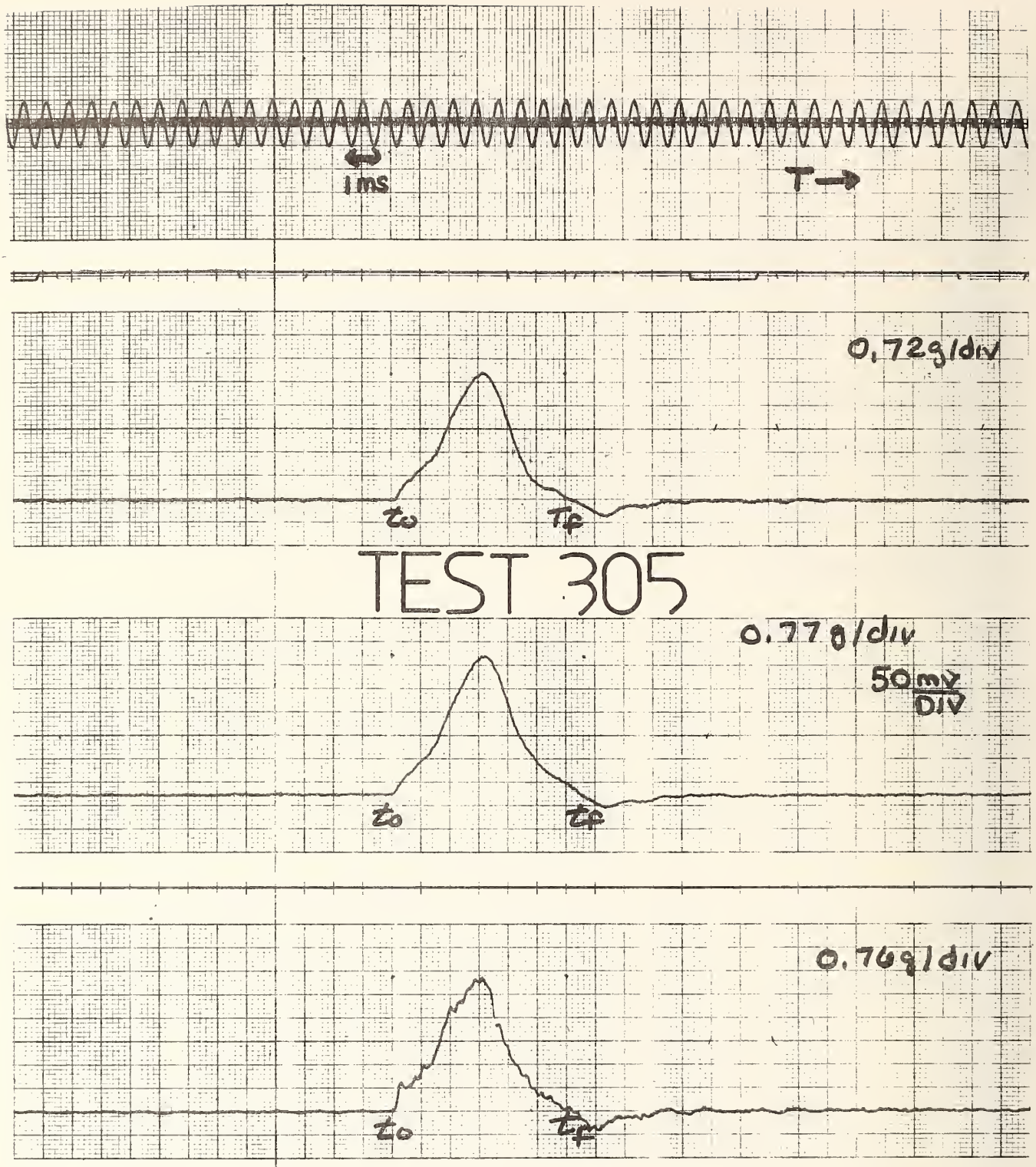
	Area	St. Area	Div.	Cal. Div.	Cal. g's	$\frac{1}{\Delta t}\int_0^{\Delta t} gdt$	Δt	$W\int_0^{\Delta t} gdt$
	36	85						
#1	41	89	29.5	12	8.64	9.3	8.4	175
	38	87						
	34	80						
#2	33	80	29	19	14.46	9.38	7.8	164
	34	80						
	30	70						
#3	34	70	27	11	8.52	9.56	7.8	167
	32	70						

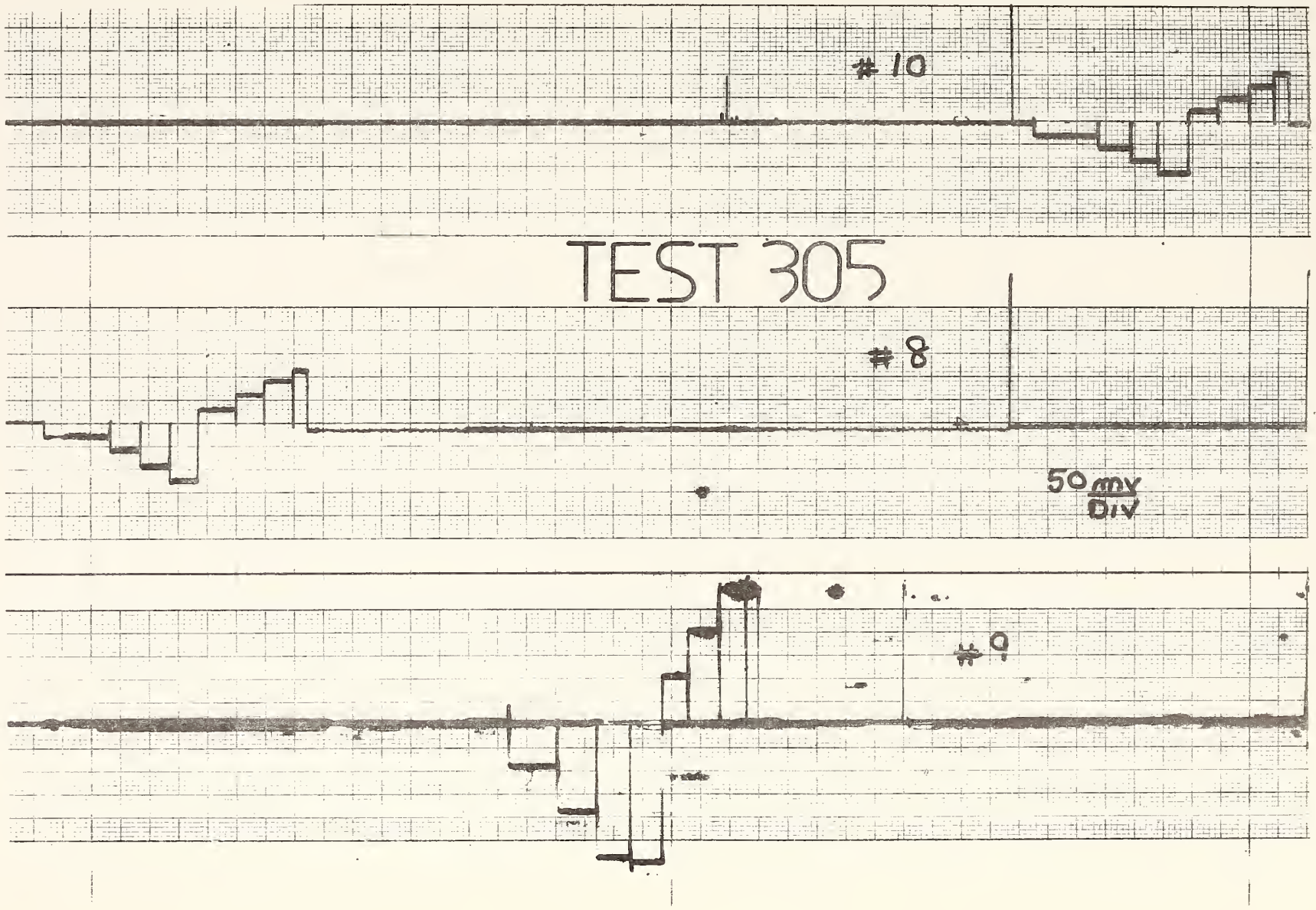
$$\frac{1}{\Delta t}\int_0^{\Delta t} gdt = \frac{\text{Area}}{\text{St. Area}} * \text{Div.} * \frac{\text{Cal. g's}}{\text{Cal. Div.}}$$

$M\Delta V = 169$ lb-Sec

$$M\Delta V = W\int_0^{\Delta t} gdt$$

DATE 3/27/75 JWA


1 ms
T
0.729/div
t_o
t_f
TEST 305
0.779/div
50 mV/DIV
t_o
t_f
0.769/div
t_o
t_f


#10
TEST 305
#8
50 mv/Div
#9

FHWA/ENSCO IMPACT TEST FACILITY
TEST REQUEST

Test No. 306

Pole/Support 8WF20 - 8 feet

Description of Setup: Hi-Lok Bolts

Camera: Required yes [ ] no [X]

Film Color [ ] B&W [ ]

Min. Speed _____

Max. Speed _____

Signals to be Recorded:

a. Accelerometers yes [X] no [ ]

b. Strain gauges yes [ ] no [X]

c. Speed transducers yes [ ] no [X]

d. Other _____

Crush Characteristics:

Honeycomb #1 N/A

#2 _____

#3 _____

Initial Speed: 20 MPH

Mass (weight of pendulum mass): 2250 lbs.

Comments: _____

FHWA/ENSCO IMPACT TEST FACILITY

Test No. 306 Date: 3/27/75 Weather: Cold

Personnel Present: JWA, RO

1. POWER

Circuit breakers on

1	[X]	2	[X]	3	[X]
4	[X]	8	[X]	10	[X]
11	[X]	13	[X]	14	[X]

2. RELEASE HOOK

Attached [X] Plugged In [X] Switch On [X]

3. ACCELEROMETERS

Mounted Correctly [X]

#1 Connected [X] 15 g's

#2 Connected [X] 50 g's

#3 Connected [X] 15 g's

Mounting Pattern of Pendulum Mass (Viewed from Rear)

[2]

[1] [3]

J-Box Connectors tightened [X]

J-Box Cable connected to Control Box [X]

#1 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

100 gain # 8 channel into Tape Recorder

#2 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

300 gain # 9 channel into Tape Recorder

#3 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

100 gain # 10 channel into Tape Recorder

4. SPEED TRANSDUCERS (N/A)

Connected correctly to reference cell [ ]

Connectors on reference cell correct [ ]

Slots lined up [ ]

Distance between first two _____ ft.

Distance between second two _____ ft.

Distance between sets _____ ft.

Connected correctly to control box [ ]

Control box on [ ]

Cable from RCDR to channel _____ on tape recorder

Cable from #1 to INPUTA on freq. counter [ ]

Frequency counter turned on [ ]

Sensitivity on [ ]

#1 recorded on channel _____

#2 recorded on channel _____

5. CAMERA (N/A)

PPS Dial _____ Mult Switch _____

Speed Reducer _____ Servo Brake _____

Drag Brake _____ F Setting _____ Film ASA _____

Light meter reading _____ Film _____

Film correct ☐ Prism correct ☐ Trip switch ☐

Camera on stop ☐ Timing light on ☐ _____pulses/sec

Balanced ☐ Remote cable on ☐ Power cable on ☐

Focus setting _____

View portal correct ☐

6. CRUSH CHARACTERISTICS (N/A)

Honeycomb: #1 _____

#2 _____

#3 _____

7. POLE Type: 8WF20 - 8 feet

Set up [X] Torqued exactly [X] Torque ≈ 110 ft-lbs.

8. TIMING LINES

Frequency 1 khz Voltage (peak to peak) 10 volts

Recorded on channel 1 input to tape recorder

9. TAPE RECORDER Tape # 001A

Speed 60 ips

Start of calibration 400

End of calibration 438 } Meter Setting

Start of Test 438

Calibration signals recorded [X]

10. MASS

Weight 2250 lbs.

Correct height [X] Est. initial velocity 20 mph

Accelerometer cables out of danger [X]

11. LAST SECOND ITEMS

Arm control box ☐ N/A

Reset frequency counter ☐

Initial # of Pulses (vis)	-
Initial # of Pulses (rec)	-
Final # of Pulses (rec)	-
Impact meter reading	354
Final meter reading	-
Correction factor for height	-
Amount of crush	-

Remarks:

TEST # 306

DATA REDUCTION
FHWA/ENSCO IMPACT TEST FACILITY

1. Speed Transducers (N/A)

A) Initial pulses _____ → _____ fps = _____ mph

B) Final pulses _____ :Cor. Factor _____ → _____ fps = _____ mph

Weight of mass = _____ lbs.

ΔMV = (weight /32.2) x (a-b) lb-sec

= _____ lb-sec

2. Accelerometers

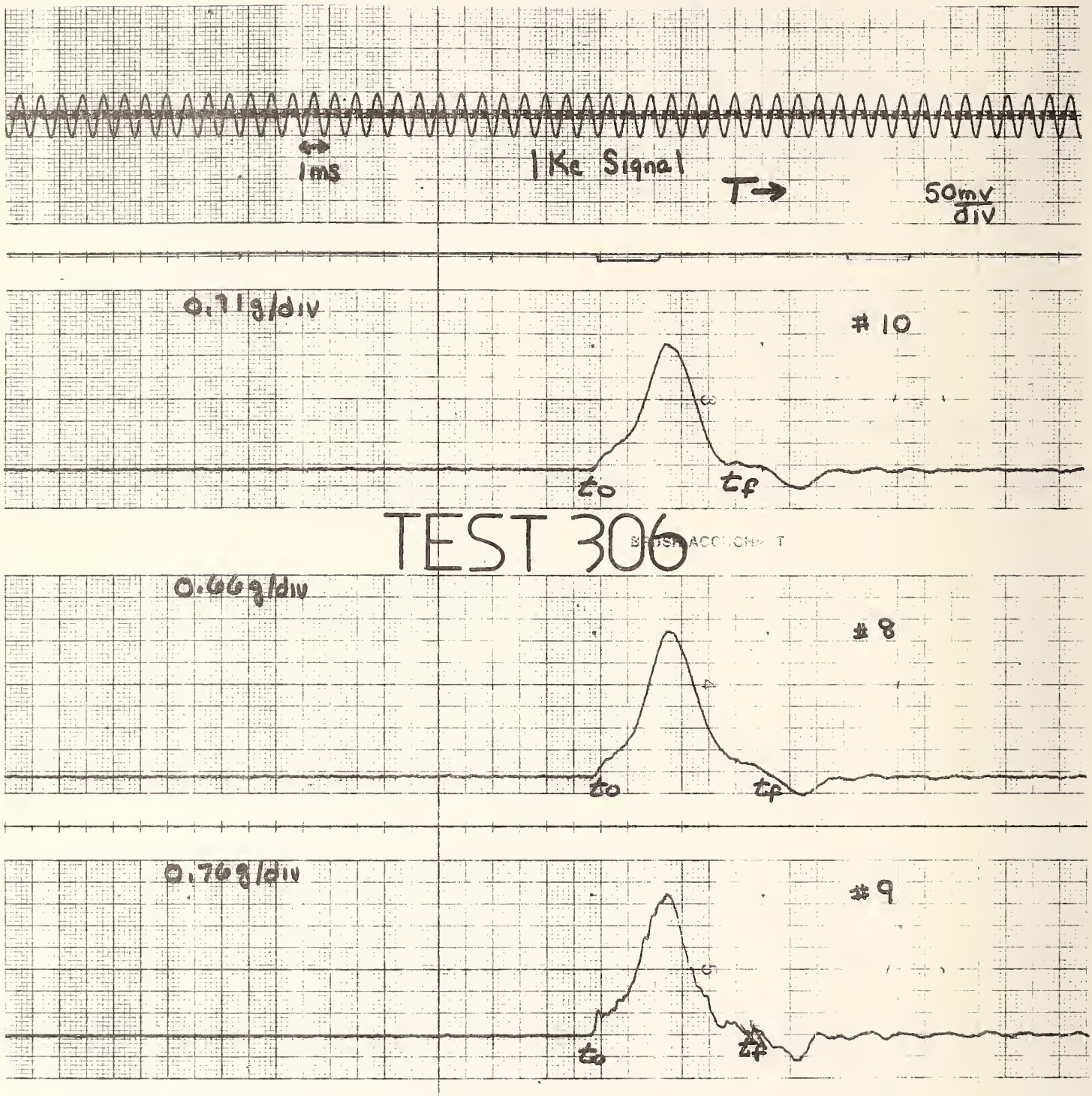
	Area	St. Area	Div.	Cal. Div.	Cal. g's	$\frac{1}{\Delta t}\int_0^{\Delta t} gdt$	Δt	$W\int_0^{\Delta t} gdt$
	36	94						
#1	37	94	33	13	8.64	8.63	8	155
	37	94						
	32	84						
#2	32	88	32	19	14.46	9.06	8	163
	32	86						
	31	77						
#3	32	80	28.5	12	8.52	8.2	8	147
	31.5	78.5						

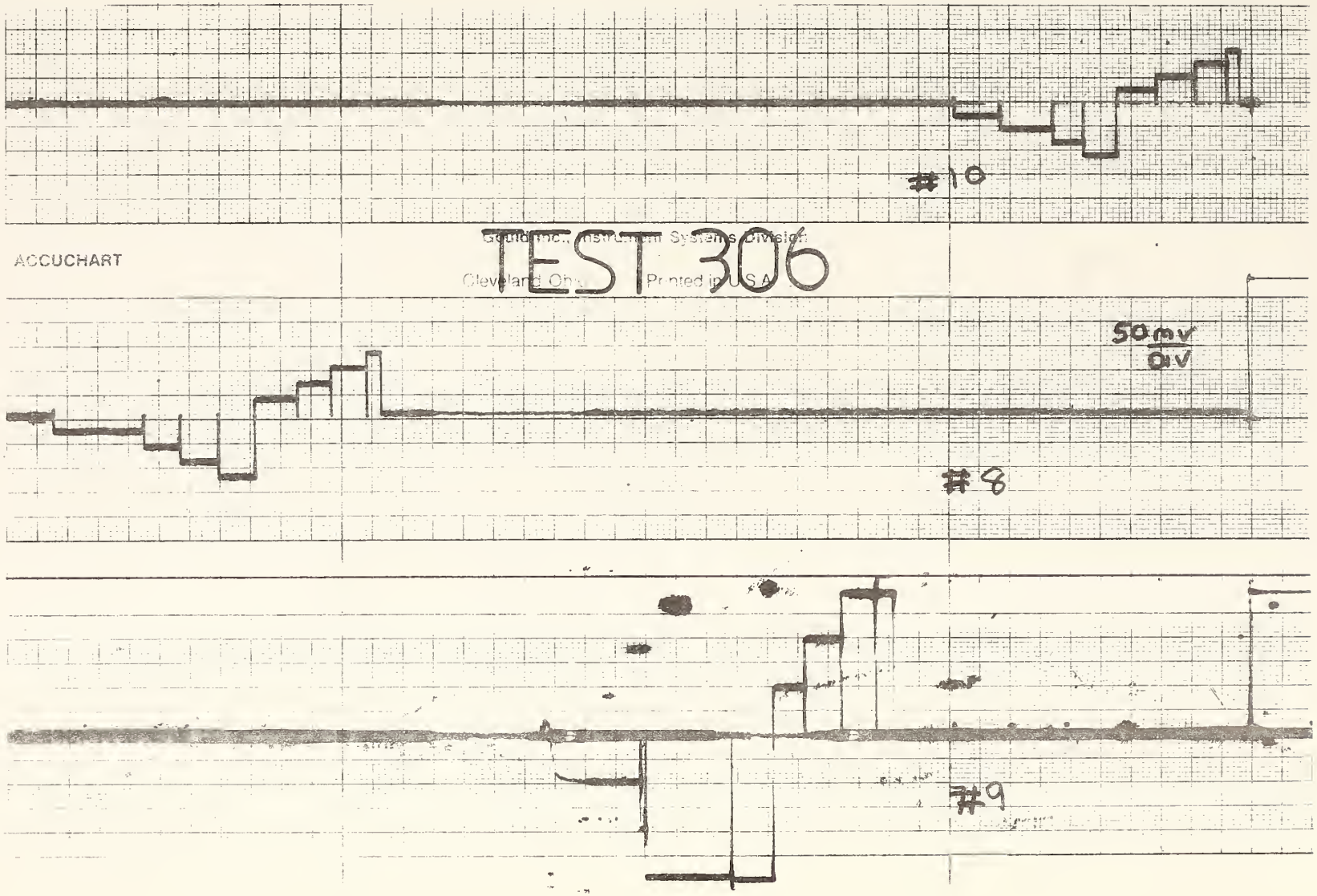
$$\frac{1}{\Delta t}\int_0^{\Delta t} gdt = \frac{\text{Area}}{\text{St. Area}} * \text{Div.} * \frac{\text{Cal. g's}}{\text{Cal. Div.}}$$

$$M\Delta V = W\int_0^{\Delta t} gdt$$

$M\Delta V$ = 155 lb-Sec

DATE 3/30/75 JWA


1ms
1Kc Signal
T→
50mv/div
0.71g/div
#10
t0
tf
TEST 306
0.66g/div
#8
t0
tf
0.76g/div
#9
t0
tf


#10
ACCUCHART
TEST 306
50 mv
div
#8
#9

FHWA/ENSCO IMPACT TEST FACILITY
TEST REQUEST

Test No. 307

Pole/Support 8WF20 8' Section

Description of Setup: F (Base) = 0

Camera: Required yes [X] no [ ]

Film Color [ ] B&W [X]

Min. Speed 500

Max. Speed 1000

Signals to be Recorded:

a. Accelerometers yes [X] no [ ]

b. Strain gauges yes [ ] no [X]

c. Speed transducers yes [ ] no [X]

d. Other _____

Crush Characteristics: N/A

Honeycomb #1 _____

#2 _____

#3 _____

Initial Speed: 20 mph

Mass (weight of pendulum mass): 2250 lbs.

Comments: _____

FHWA/ENSCO IMPACT TEST FACILITY

Test No. 307 Date: 4/2/75 Weather: Good

Personnel Present: JWA, GK

1. POWER

Circuit breakers on

1	✓	2	✓	3	✓
4	✓	8	✓	10	✓
11	✓	13	✓	14	✓

2. RELEASE HOOK

Attached ✓ Plugged In ✓ Switch On ✓

3. ACCELEROMETERS

Mounted Correctly ✓

#1 Connected ✓ 15 g's

#2 Connected ✓ 50 g's

#3 Connected ✓ 15 g's

Mounting Pattern of Pendulum Mass (Viewed from Rear)

2

1 3

J-Box Connectors tightened ✓

J-Box Cable connected to Control Box ✓

#1 10 volts Balanced [✓] Excitation [✓] Amp. Bal. [✓]

100 gain # 8 channel into Tape Recorder

#2 10 volts Balanced [✓] Excitation [✓] Amp. Bal. [✓]

300 gain # 9 channel into Tape Recorder

#3 10 volts Balanced [✓] Excitation [✓] Amp. Bal. [✓]

100 gain # 10 channel into Tape Recorder

4. SPEED TRANSDUCERS N/A

Connected correctly to reference cell [ ]

Connectors on reference cell correct [ ]

Slots lined up [ ]

Distance between first two _____ ft.

Distance between second two _____ ft.

Distance between sets _____ ft.

Connected correctly to control box [ ]

Control box on [ ]

Cable from RCDR to channel _____ on tape recorder

Cable from #1 to INPUTA on freq. counter [ ]

Frequency counter turned on [ ]

Sensitivity on [ ]

#1 recorded on channel _____

#2 recorded on channel _____

5. CAMERA

PPS Dial 80 Mult Switch 10

Speed Reducer H Servo Brake L

Drag Brake 30 F Setting 5.6 Film ASA 400

Light meter reading 14 Film B & W

Film correct [✓] Prism correct [✓] Trip switch [✓]

Camera on stop [✓] Timing light on [✓] 100 pulses/sec

Balanced [✓] Remote cable on [✓] Power cable on [✓]

Focus setting 50

View portal correct [X]

6. CRUSH CHARACTERISTICS N/A

Honeycomb: #1 _____

#2 _____

#3 _____

7. POLE Type: 8 WF20

Set up [✓] Torqued exactly [✓] Torque ~0 ft-lbs.

8. TIMING LINES

Frequency 1 K hz Voltage (peak to peak) 10 volts

Recorded on channel 1 input to tape recorder

9. TAPE RECORDER Tape # 001A

Speed 60 ips

Start of calibration 661

End of calibration 700] Meter Setting

Start of Test 700

Calibration signals recorded [✓]

10. MASS

Weight 2250 lbs.

Correct height [✓] Est. initial velocity 20 mph

Accelerometer cables out of danger [✓]

11. LAST SECOND ITEMS

Arm control box ☐ N/A

Reset frequency counter ☐

Initial # of Pulses (vis) —

Initial # of Pulses (rec) —

Final # of Pulses (rec) —

Impact meter reading —

Final meter reading 727

Correction factor for height —

Amount of crush —

Remarks:

TEST # 307

DATA REDUCTION
FHWA/ENSCO IMPACT TEST FACILITY

1. Speed Transducers N/A

A) Initial pulses _____ → _____ fps = _____ mph

B) Final pulses _____ :Cor. Factor _____ → _____ fps = _____ mph

Weight of mass = _____ lbs.

ΔMV = (weight /32.2) x (a-b) lb-sec

= _____ lb-sec

2. Accelerometers

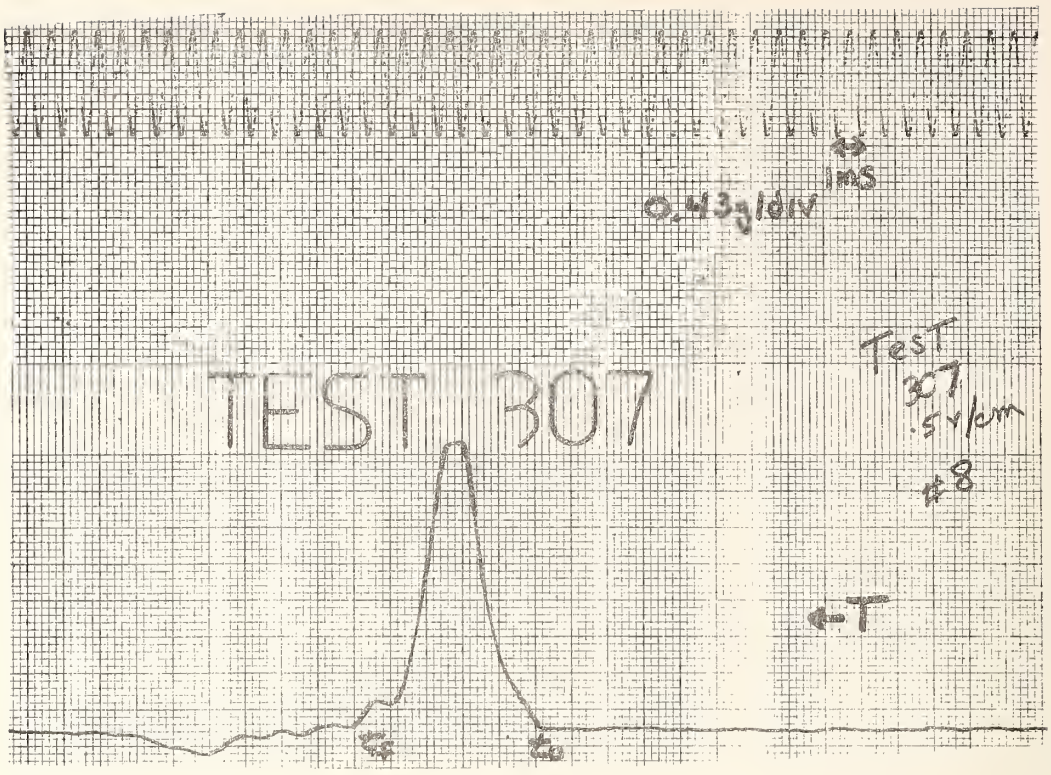
	Area	St. Area	Div.	Cal. Div.	Cal. g's	$\frac{1}{\Delta t}\int_0^{\Delta t} gdt$	Δt	$W\int_0^{\Delta t} gdt$
	45	130						
#1	43	127	40	20	8.64	5.94	9.5	126
	44	128						
	38	87						
#2	40	86	35	32	14.46	7.2	7.0	113
	39	86						
	41	113						
#3	44	110	40	20	8.52	6.4	7.8	112
	42	112						

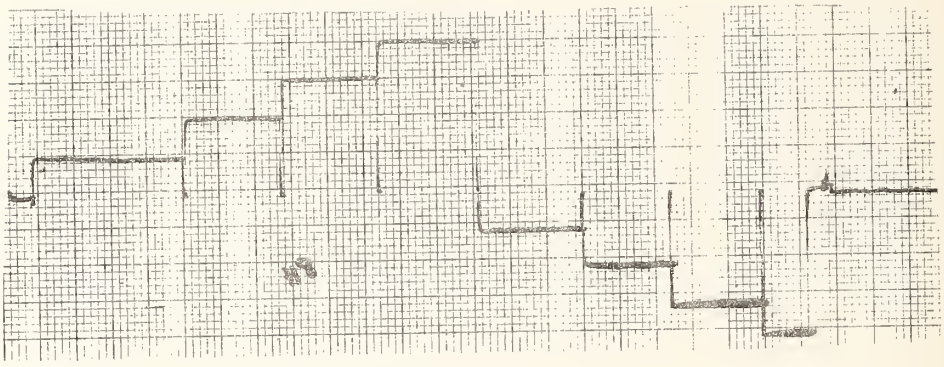
$$\frac{1}{\Delta t}\int_0^{\Delta t} gdt = \frac{\text{Area}}{\text{St. Area}} * \text{Div.} * \frac{\text{Cal. g's}}{\text{Cal. Div.}}$$

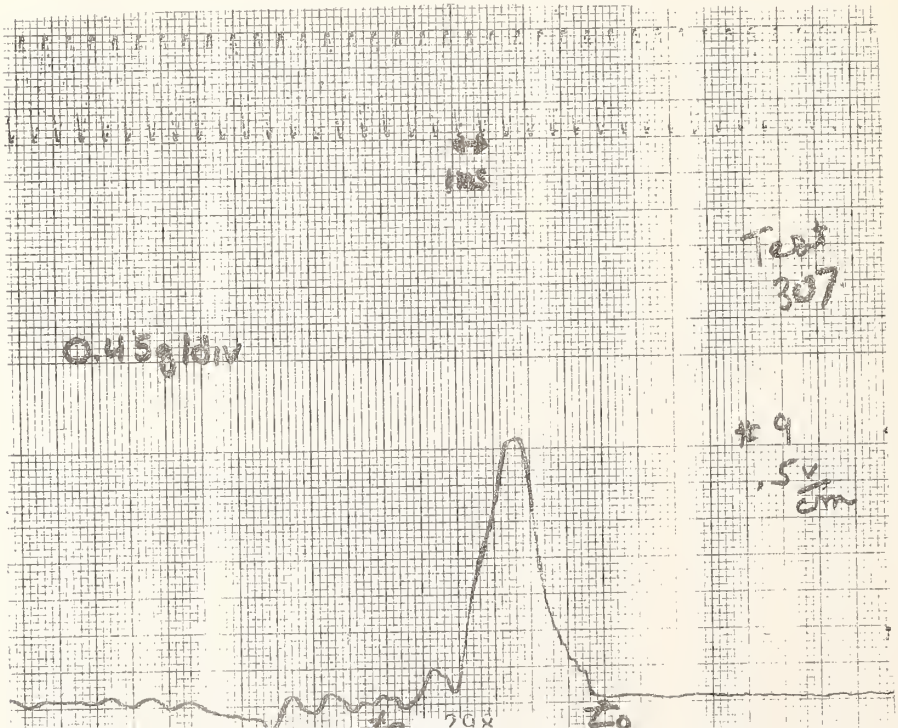
$$M\Delta V = W\int_0^{\Delta t} gdt$$

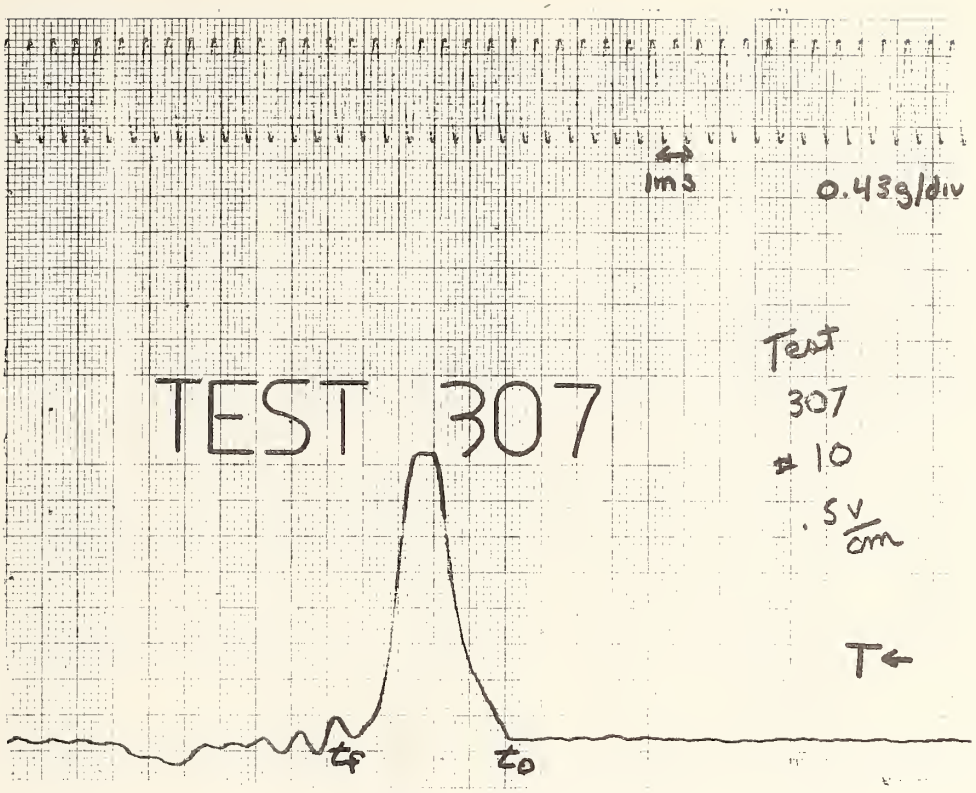
$M\Delta V$ = 117 lb-Sec

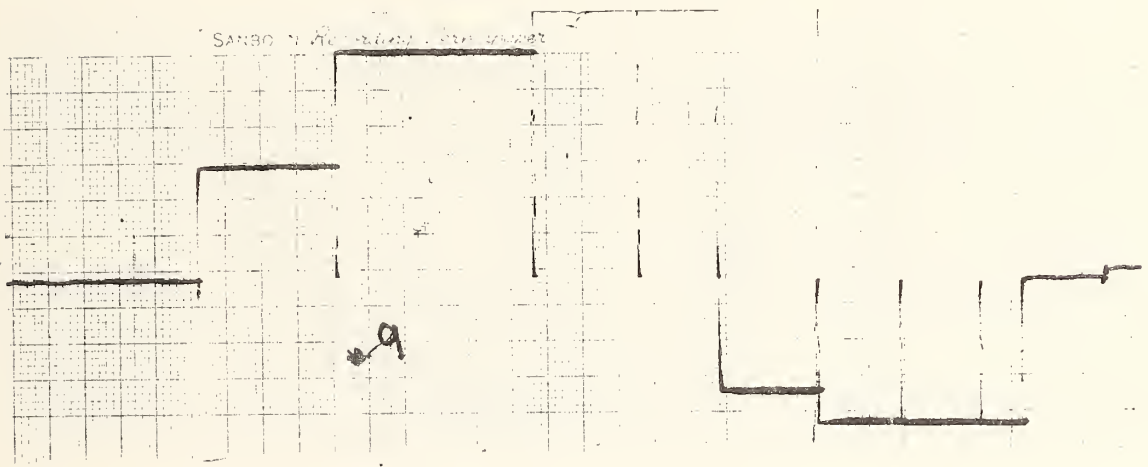
DATE 4/2/75 JWA


1mS
0.43g/div
TEST 307
Test
307
.5v/cm
#8
←T




1mS
Test
307
0.45g/div
#9
.5v/cm


1ms
0.43g/div
TEST 307
Test
307
#10
.5 v/cm
T←
t_f
t_0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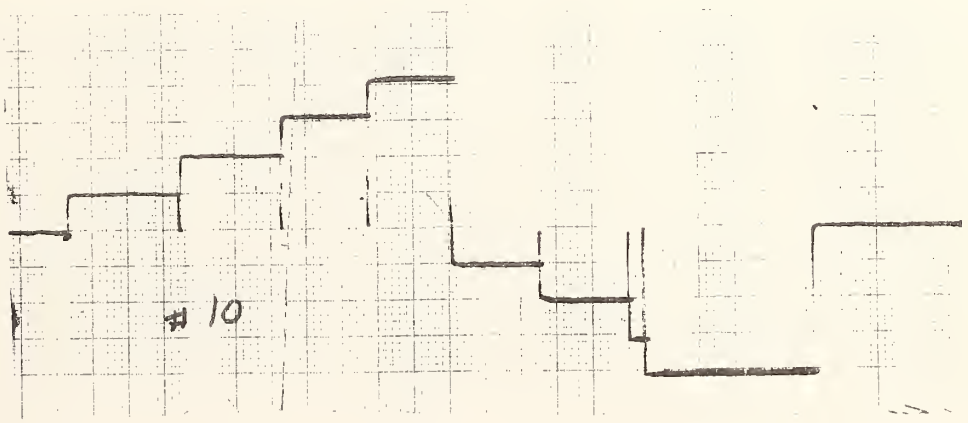

#10

FHWA/ENSCO IMPACT TEST FACILITY
TEST REQUEST

Test No. 308

Pole/Support 8 Wide Flange 20 - 8 feet

Description of Setup: No force on base

Camera: Required yes [X] no [ ]

Film Color [ ] B&W [X]

Min. Speed _____

Max. Speed _____

Signals to be Recorded:

a. Accelerometers yes [X] no [ ]

b. Strain gauges yes [ ] no [X]

c. Speed transducers yes [ ] no [X]

d. Other _____

Crush Characteristics:

Honeycomb #1 N/A

#2 _____

#3 _____

Initial Speed: 20 MPH

Mass (weight of pendulum mass): 2250 lbs.

Comments: _____

FHWA/ENSCO IMPACT TEST FACILITY

Test No. 308 Date: 4/2/75 Weather: Sunny, Windy, Warm

Personnel Present: JWA, GK

1. POWER

Circuit breakers on

1	[X]	2	[X]	3	[X]
4	[X]	8	[X]	10	[X]
11	[X]	13	[X]	14	[X]

2. RELEASE HOOK

Attached [X] Plugged In [X] Switch On [X]

3. ACCELEROMETERS

Mounted Correctly [X]

#1 Connected [X] 15 g's

#2 Connected [X] 50 g's

#3 Connected [X] 15 g's

Mounting Pattern of Pendulum Mass (Viewed from Rear)

[2]

[1] [3]

J-Box Connectors tightened [X]

J-Box Cable connected to Control Box [X]

#1 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

100 gain # 8 channel into Tape Recorder

#2 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

300 gain # 9 channel into Tape Recorder

#3 10 volts Balanced [X] Excitation [X] Amp. Bal. [X]

100 gain # 10 channel into Tape Recorder

4. SPEED TRANSDUCERS (N/A)

Connected correctly to reference cell [ ]

Connectors on reference cell correct [ ]

Slots lined up [ ]

Distance between first two _____ ft.

Distance between second two _____ ft.

Distance between sets _____ ft.

Connected correctly to control box [ ]

Control box on [ ]

Cable from RCDR to channel _____ on tape recorder

Cable from #1 to INPUTA on freq. counter [ ]

Frequency counter turned on [ ]

Sensitivity on [ ]

#1 recorded on channel _____

#2 recorded on channel _____

5. CAMERA

PPS Dial 80 Mult Switch 10

Speed Reducer H Servo Brake L

Drag Brake 30 F Setting 5.6 Film ASA 400

Light meter reading 14.25 Film B&W

Film correct [X] Prism correct [X] Trip switch [X]

Camera on stop [X] Timing light on [X] 100 pulses/sec

Balanced [X] Remote cable on [X] Power cable on [X]

Focus setting 50 feet

View portal correct [X]

6. CRUSH CHARACTERISTICS

Honeycomb: #1 N/A

#2

#3

7. POLE Type: 8WF20 8 feet

Set up [X] Torqued exactly [X] Torque ~0 ft-lbs.

8. TIMING LINES

Frequency 1 khz Voltage (peak to peak) 10 volts

Recorded on channel 1 input to tape recorder

9. TAPE RECORDER Tape # 001A

Speed 60 ips

Start of calibration 540

End of calibration 574 Meter Setting

Start of Test 574

Calibration signals recorded [X]

10. MASS

Weight 2250 lbs.

Correct height [X] Est. initial velocity 20 mph

Accelerometer cables out of danger [X]

11. LAST SECOND ITEMS (N/A)

Arm control box ☐

Reset frequency counter ☐

Initial # of Pulses (vis) _____

Initial # of Pulses (rec) _____

Final # of Pulses (rec) _____

Impact meter reading _____

Final meter reading _____

Correction factor for height _____

Amount of crush _____

Remarks:

Lens Cap on

TEST # 308

DATA REDUCTION
FHWA/ENSCO IMPACT TEST FACILITY

1. Speed Transducers (N/A)

A) Initial pulses _____ → _____ fps = _____ mph

B) Final pulses _____ :Cor. Factor _____ → _____ fps = _____ mph

Weight of mass = _____ lbs.

ΔMV = (weight /32.2) x (a-b) lb-sec

= _____ lb-sec

2. Accelerometers

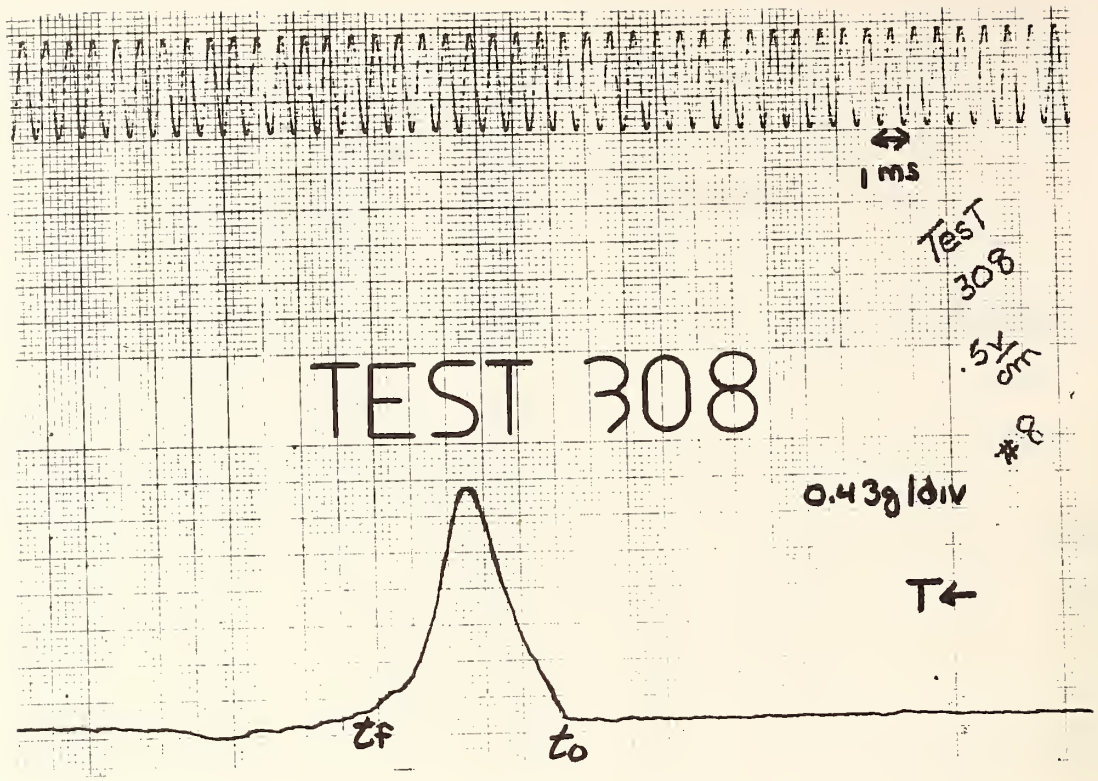
	Area	St. Area	Div.	Cal. Div.	Cal. g's	$\frac{1}{\Delta t}\int_0^{\Delta t} gdt$	Δt	$W\int_0^{\Delta t} gdt$
	40	108						
#1	46	104	32	20	8.64	5.61	9.0/1000	113
	43	106						
	35	82						
#2	38	82	28	31	14.46	5.90	8.5/1000	113
	37	82						
	45	112						
#3	42	108	33	20.5	8.52	5.49	9.0/1000	111
	44	110						

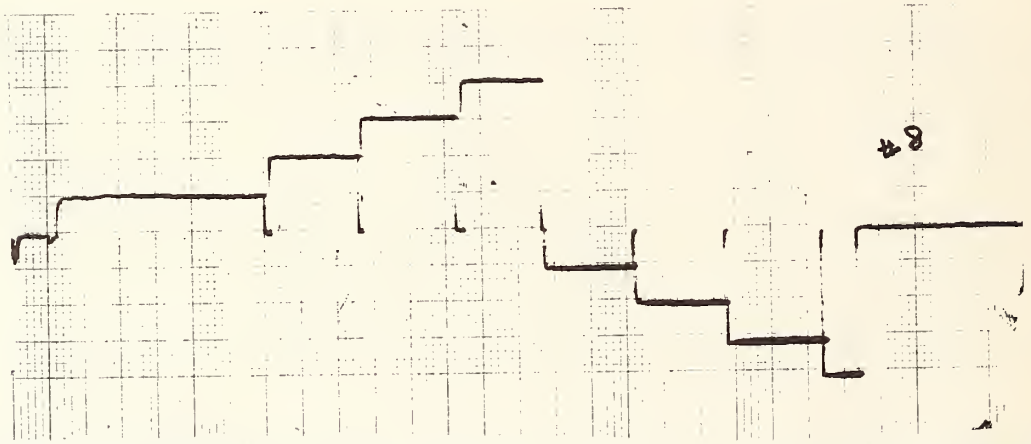
$$\frac{1}{\Delta t}\int_0^{\Delta t} gdt = \frac{\text{Area}}{\text{St. Area}} * \text{Div.} * \frac{\text{Cal. g's}}{\text{Cal. Div.}}$$

$M\Delta V = 112$ lb-Sec

$$M\Delta V = W\int_0^{\Delta t} gdt$$

DATE 4/2/75 JWA


1 ms
Test
308
.5 V/cm
#9
TEST 308
0.43g/div
T←
tf
to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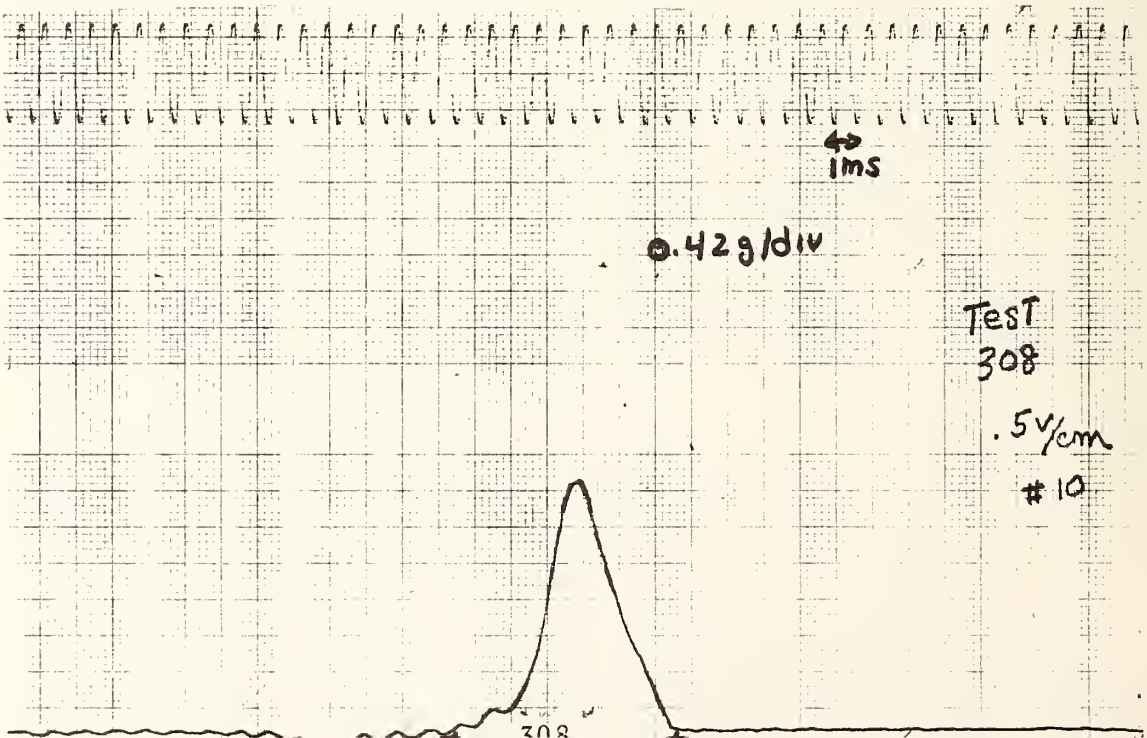
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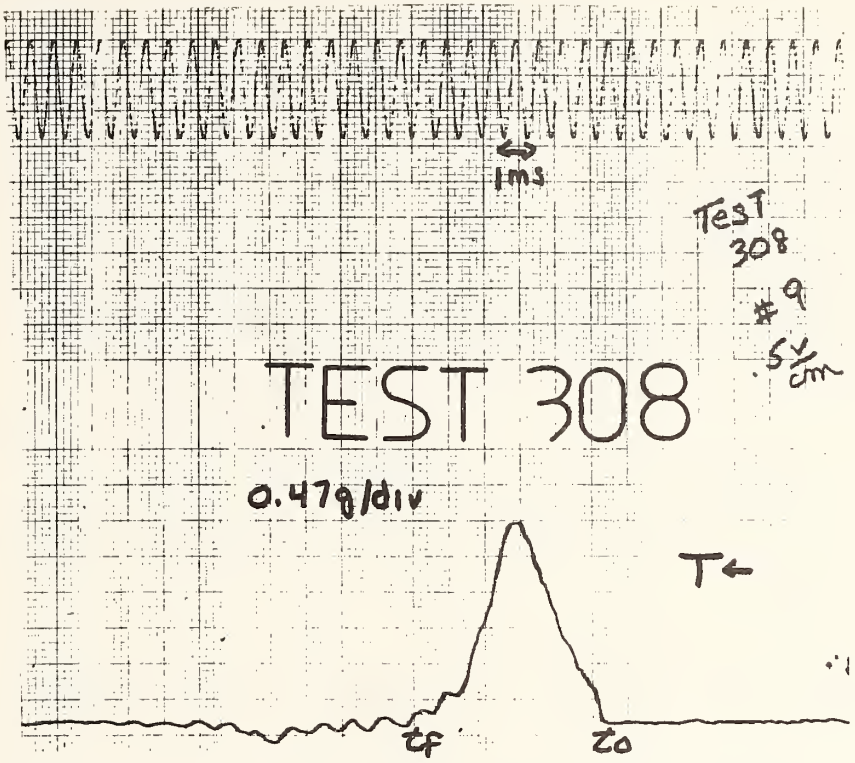
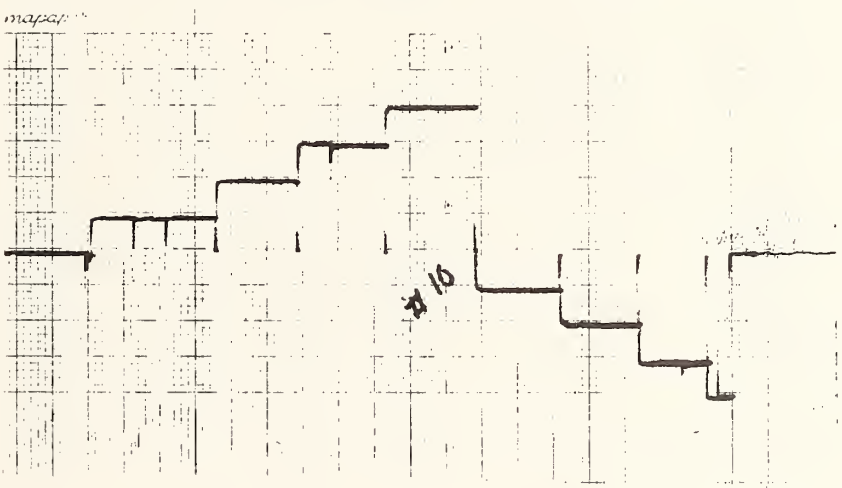
0.42g/div
Test
308
.5 V/cm
#10
308


1ms
Test
308
#9
.5V/cm
TEST 308
0.47g/div
T←
tf
to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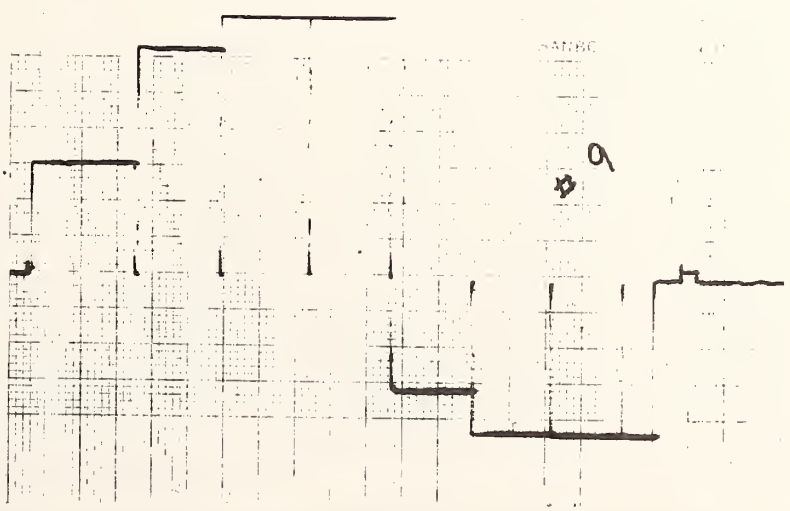

#9

FHWA/ENSCO IMPACT TEST FACILITY
TEST REQUEST

Test No. 309

Pole/Support 8WF20 8'

Description of Setup: Hi-Lok Bolts

Camera: Required yes [✓] no [ ]

Film Color [ ] B&W [✓]

Min. Speed 500

Max. Speed 1000

Signals to be Recorded:

a. Accelerometers yes [✓] no [ ]

b. Strain gauges yes [ ] no [✓]

c. Speed transducers yes [ ] no [✓]

d. Other _____

Crush Characteristics: N/A

Honeycomb #1 _____

#2 _____

#3 _____

Initial Speed: 20 mph

Mass (weight of pendulum mass): 2250 lbs.

Comments: _____

FHWA/ENSCO IMPACT TEST FACILITY

Test No. 309 Date: 4/2/75 Weather: _____

Personnel Present: JWA, GK

1. POWER

Circuit breakers on

1	✓	2	✓	3	✓
4	✓	8	✓	10	✓
11	✓	13	✓	14	✓

2. RELEASE HOOK

Attached ✓ Plugged In ✓ Switch On ✓

3. ACCELEROMETERS

Mounted Correctly ✓

#1 Connected ✓ 15 g's

#2 Connected ✓ 50 g's

#3 Connected ✓ 15 g's

Mounting Pattern of Pendulum Mass (Viewed from Rear)

2

1 3

J-Box Connectors tightened ✓

J-Box Cable connected to Control Box ✓

#1 10 volts Balanced [✓] Excitation [✓] Amp. Bal. [✓]

100 gain # 8 channel into Tape Recorder

#2 10 volts Balanced [✓] Excitation [✓] Amp. Bal. [✓]

300 gain # 9 channel into Tape Recorder

#3 10 volts Balanced [✓] Excitation [✓] Amp. Bal. [✓]

100 gain # 10 channel into Tape Recorder

4. SPEED TRANSDUCERS N/A

Connected correctly to reference cell [ ]

Connectors on reference cell correct [ ]

Slots lined up [ ]

Distance between first two _____ ft.

Distance between second two _____ ft.

Distance between sets _____ ft.

Connected correctly to control box [ ]

Control box on [ ]

Cable from RCDR to channel _____ on tape recorder

Cable from #1 to INPUTA on freq. counter [ ]

Frequency counter turned on [ ]

Sensitivity on [ ]

#1 recorded on channel _____

#2 recorded on channel _____

5. CAMERA

PPS Dial 80 Mult Switch 10

Speed Reducer H Servo Brake L

Drag Brake 30 F Setting 5.6 Film ASA 400

Light meter reading 14 Film B & W

Film correct [✓] Prism correct [✓] Trip switch [✓]

Camera on stop [✓] Timing light on [✓] 100 pulses/sec

Balanced [✓] Remote cable on [✓] Power cable on [✓]

Focus setting 50

View portal correct [✓]

6. CRUSH CHARACTERISTICS N/A

Honeycomb: #1 _____

#2 _____

#3 _____

7. POLE Type: 8 WF 20

Set up [✓] Torqued exactly [✓] Torque ~110 ft-lbs.

8. TIMING LINES

Frequency 1 K hz Voltage (peak to peak) 10 volts

Recorded on channel 1 input to tape recorder

9. TAPE RECORDER Tape # 001A

Speed 60 ips

Start of calibration 600

End of calibration 638 Meter Setting

Start of Test 638

Calibration signals recorded ✓

10. MASS

Weight 2250 lbs.

Correct height ✓ Est. initial velocity 20 mph

Accelerometer cables out of danger ✓

11. LAST SECOND ITEMS

Arm control box ☐

Reset frequency counter ☐

Initial # of Pulses (vis)	_____
Initial # of Pulses (rec)	= _____
Final # of Pulses (rec)	= _____
Impact meter reading	– _____
Final meter reading	657
Correction factor for height	– _____
Amount of crush	– _____

Remarks:

TEST # 309

DATA REDUCTION
FHWA/ENSCO IMPACT TEST FACILITY

1. Speed Transducers N/A

A) Initial pulses — → — fps = — mph

B) Final pulses _____ :Cor. Factor — → _____ fps = — mph

Weight of mass = _____ lbs.

ΔMV = (weight /32.2) x (a-b) lb-sec

= — lb-sec

2. Accelerometers

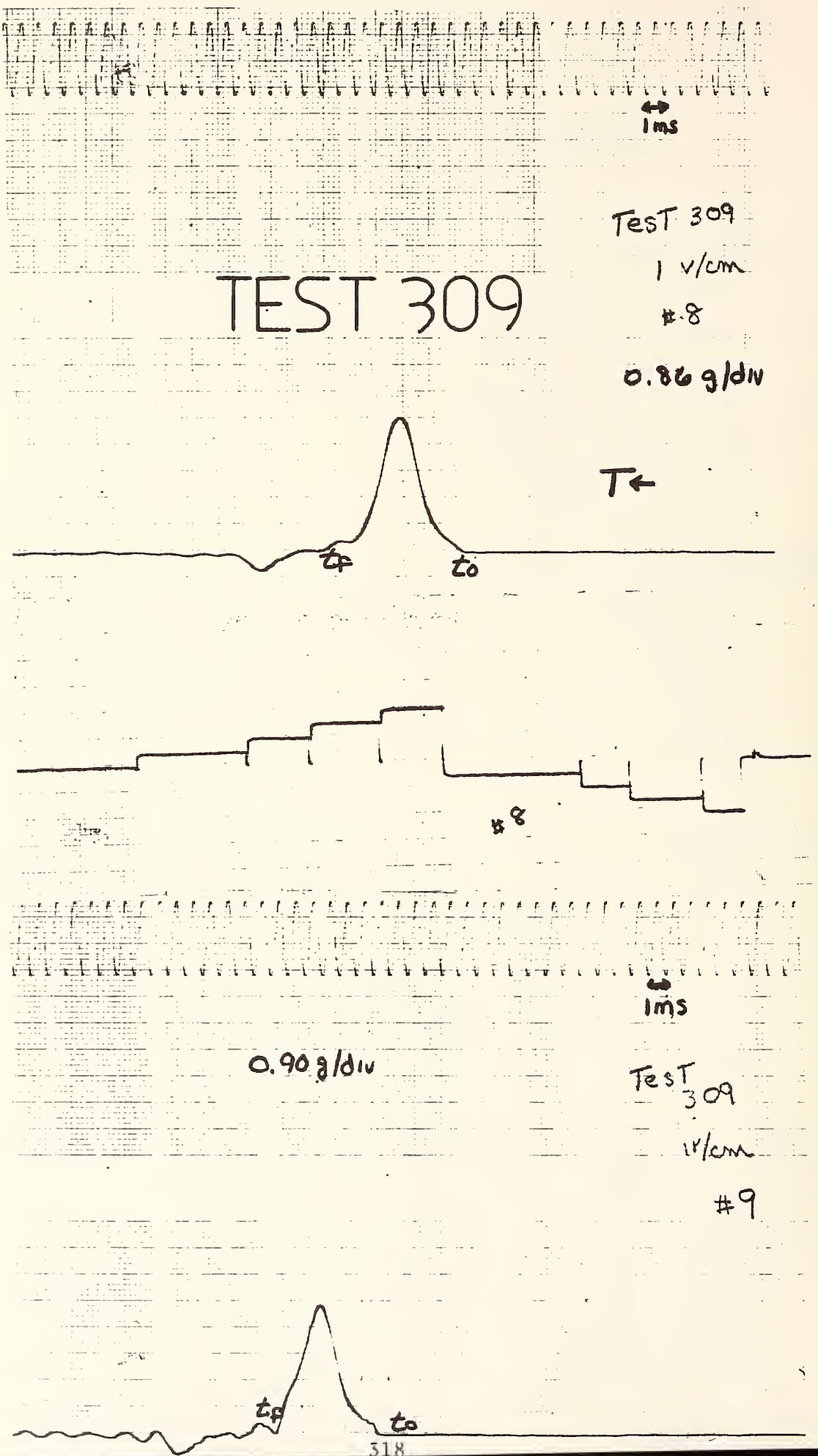
	Area	St. Area	Div.	Cal. Div.	Cal. g's	$\frac{1}{\Delta t}\int_0^{\Delta t} gdt$	Δt	$W\int_0^{\Delta t} gdt$
	27	74						
#1	30	73	25	10	8.64	8.3	8/1000	149
	28	73						
	24	54						
#2	24	52	24	16	14.46	9.8	7/1000	155
	24	53						
	25	66						
#3	28	62	24	10	8.52	8.6	8/1000	155
	27	64						

$$\frac{1}{\Delta t}\int_0^{\Delta t} gdt = \frac{\text{Area}}{\text{St. Area}} * \text{Div.} * \frac{\text{Cal. g's}}{\text{Cal. Div.}}$$

$M\Delta V = W\int_0^{\Delta t} gdt$

$M\Delta V$ = 153 lb-Sec

DATE 4/2/75 JWA


1ms
TEST 309
TesT 309
1 v/cm
#8
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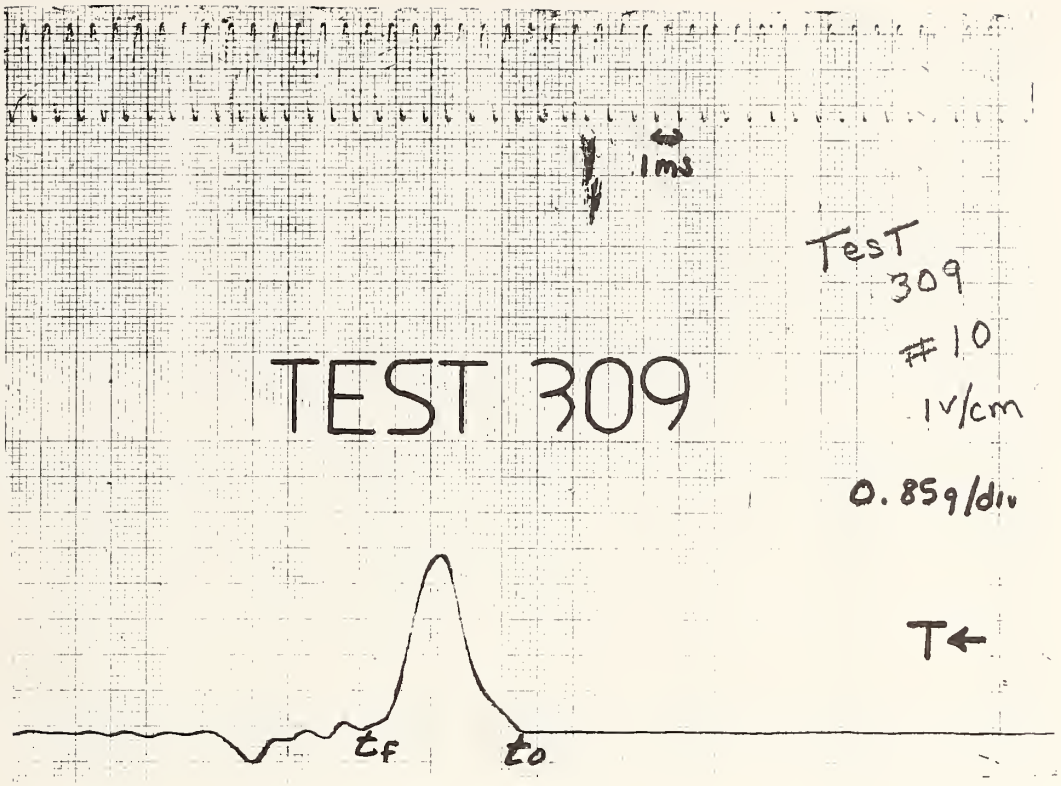
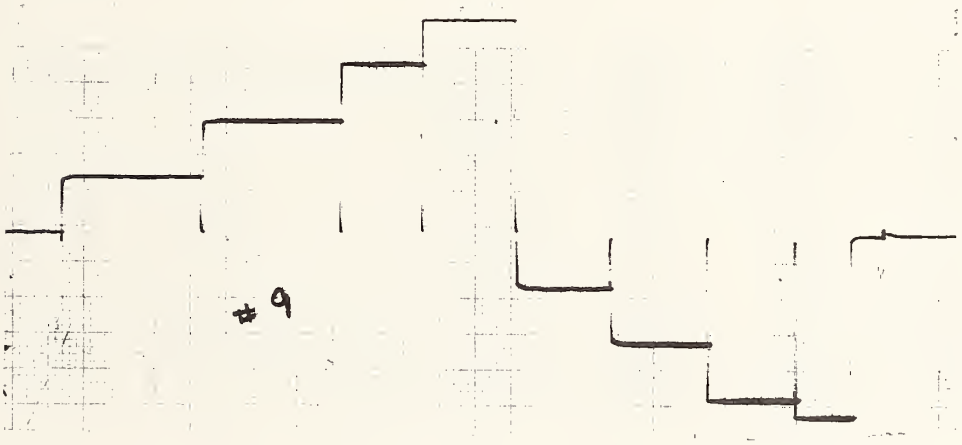
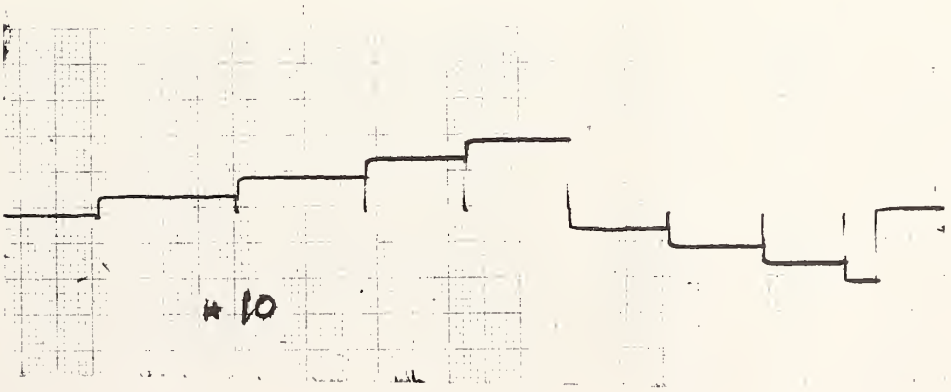
T←
tf
to
#8
1ms
0.90 g/div
TesT 309
1V/cm
#9
tf
to







GPO 908-418

TE 662
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BORROWER

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